VOL. XIII NO. 6

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

DECEMBER 1923

SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 WEST 39TH STREET NEW YORK

Home of Watson Stabilator Company of Philadelphia

The kind of Distributors who sell them

THE matter of making motor cars more roadable is rapidly becoming one of the most important branches of the Automotive Industry, and the reason for the particularly rapid and sound growth of STABILATOR Distribution is due to the fact that the riding betterments produced by STABILATORS are not imaginary, but real.

The STABILATOR Distributor is a pioneer; he has the work of presenting to the hundreds of thousands of motorists in his territory, through his Wholesale and Retail Departments, the fact that easy riding and better roadability can be produced only by a strict observance of and adherence to certain fundamental laws of physics. In his work of winning the confidence of the motorist, and thereby being granted the opportunity to help the motorist secure real motoring roadability, he must combat the present lure of devices made attractive because of cheapness and devices which hypnotize because of costliness. His pioneering work is not easy. But the STABILATOR Distributor knows that he is building on a solid rock for a future which is beyond any power to estimate.

Call on any few or many of the present STABILATOR Distributing Companies. By the caliber of men you meet you will be able to judge what the future holds for them. Each of these Distributing Companies is representative of the sound worth of STABILATORS and the strength of STABILATOR business.

The Philadelphia Company enjoys the STABILATOR Distributing Franchise for Southeastern Pennsylvania, Southern New Jersey, Eastern Shore of Maryland and the State of Delaware. Its sales activities are divided into three Departments: Metropolitan Trade, Metropolitan Retail, Territorial Wholesale. It is an Automotive Institution.

JOHN WARREN WATSON COMPANY
Twenty-fourth and Locust Streets
Philadelphia

WATSON STABILATORS

Change the Whole Nature of Your Car

THE

JOURNAL
OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

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H. W. ALDEN, *President* COKER F. CLARKSON, *Secretary* C. B. WHITTELSEY, *Treasurer*

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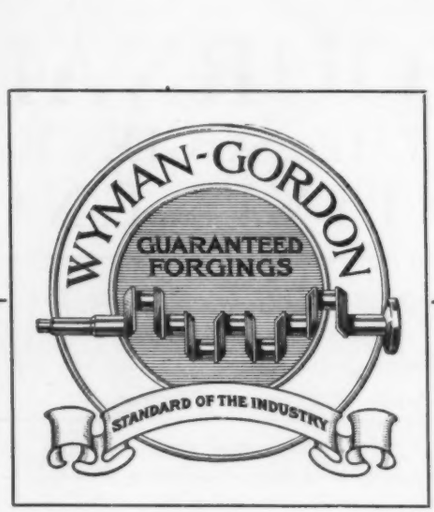

NEW YORK SHOW

We shall exhibit a complete line of crankshaft forgings at the New York Automobile Show.

Of particular interest will be our display of sections of forgings showing internal structure and flow of metal.

WYMAN-GORDON

"The Crankshaft Makers"

SPACES 335-336-337—THE ARMORY

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

Vol. XIII December, 1923 No. 6

Chronicle and Comment

Discussion of Factory Problems

THIS issue of THE JOURNAL contains the corrected report of the discussion that followed the several papers read at the Production Meeting in Cleveland on Oct. 25 and 26. Frequently it is found that the discussion of a paper adds materially to its value, bringing out points not covered by the author; this is true of many of the Cleveland meeting papers. The discussion will prove interesting reading as an important supplement to the papers that appeared in the November issue of THE JOURNAL. All the Production Meeting discussion is grouped together, starting on p. 473.

Annual Dinner in New York

ALTHOUGH the Annual Meeting of the Society has been moved to Detroit for 1924, that great institution of the automotive industry, the Society's Annual Dinner, will be held in New York City as in years past. Attracting upward of 1000 men, this function can truthfully be called the largest formal gathering of automotive men held during the year. It will be held at the Astor Hotel on Thursday evening, Jan. 10. E. S. Jordan has agreed to take the helm as toastmaster on this occasion. Men prominent in public life will give inspiring talks and the usual atmosphere of good-fellowship will prevail. Application blanks to be used in ordering Dinner tickets will reach the members with the next issue of the *Meetings Bulletin* about Dec. 15.

New Detroit Section Office

AFTER Dec. 1, the office of the Detroit Section will be located in the General Motors Building, where it will be more accessible to the members and in a position to render increased service. Members living in the Detroit area are invited to call and inspect the new quarters. A file of the publications of the Society is available for reference purposes, and the Assistant Secretary who is in charge will be pleased to supply information on any of the Society services or activities. Men seeking positions will find bulletins of the national employment service of the New York City office on file there and assistance will be given in finding local employment as well. Car and parts companies in the Detroit district will find the national employment service an efficient means of securing experienced personnel. The New York City office maintains an intimate contact with the Detroit office and many matters pertaining to national activities can be handled efficiently through the local Assistant Secretary in the General Motors Building.

A Meeting for Motorboat Engineers

ON the morning of Jan. 9, the Society will hold its annual Motorboat Meeting and Luncheon at the Hotel Commodore, New York City. This meeting is arranged to enable engineers interested in the design of motorboats and marine engines to discuss the major engineering problems in their field. It also offers them an opportunity to become better acquainted with one another and to exchange experience for the general benefit of the motorboat industry. This date occurs during the week of the national Motorboat Show in New York City. It is planned to have two papers and a round-table discussion in the meeting, which will start at 10:30 a. m. The luncheon will follow at 1 o'clock and will be concluded with a brief talk by one of the Country's foremost motorboat enthusiasts.

American Petroleum Institute Meeting

OUR members have been invited by the American Petroleum Institute to attend the meetings that will be a part of its convention in St. Louis, Dec. 11 to 13. Several papers will be read at these meetings on different phases of the automotive-fuel problem. Some of these will be given by members of the Society who will represent it on the program. Results of the fuel-volatility research conducted at the Bureau of Standards under the direction of the Research Committee of the Society will be presented. This work is being financed jointly by the American Petroleum Institute and the National Automobile Chamber of Commerce. Automotive lubricants also will receive consideration in these meetings. See p. 516 of this issue for the divisions of the program that are of particular interest to automotive engineers.

The Dayton Service Meeting

A REPORT of the Service Meeting held at Dayton on Nov. 20 and 21 is printed in this issue of THE JOURNAL, starting on p. 523. This meeting was held under the joint auspices of the Society and the National Automobile Chamber of Commerce for the purpose of

bettering automotive service and promoting closer co-operation between motor-car designers and the service-men who maintain intimate contact with the motoring public. Future meetings of this character are to be made very comprehensive in scope, bringing the service and dealer associations into the direction of the meeting so that it will be representative of all groups interested in automobile maintenance. The success of the Dayton meeting indicates that the influence of this annual assembly of service engineers will go a long way toward eradicating the service complaints of the motorist, both real and imaginary.

Annual Meeting in Detroit

IN all probability the 1924 Annual Meeting will be attended by more members than any previous national gathering of the Society. This seems likely because the meeting will be held in Detroit near the geographical center of the industry and will not conflict with the numerous meetings, luncheons, social functions and show duties that have demanded so much of a member's time during the New York Show week. Professional sessions will run for 4 days from Jan. 22 to 25. Papers are being selected for their informative value and will be of a high standard. Topics of current interest will be the only ones discussed. There will be something for the designer, the research engineer, the production man and the service executive. All the latest models of passenger cars will be on display at the Detroit Automobile Show during the week of the meeting. Reduced railroad-fares from all important automotive centers will minimize the expense of attendance. Complete announcement of the arrangements made to date appears on p. 530 of this issue.

Discussion of Sections' Methods

AT the last meeing of the Council, the following were named as members of a special committee to study and improve so far as possible the methods of procedure of the Sections: B. B. Bachman, *chairman;* J. H. Hunt, T. J. Litle, Jr., H. W. Slauson and John Younger. Considerable correspondence has been conducted recently by the Sections Committee and this special committee for the purpose of securing comments from those members who are specially qualified by experience to discuss Sections affairs.

There is much sentiment in favor of reestablishing the Section Associate, but not all of the Sections favor such enrollment of non-members of the Society as affiliates of the Sections. There is also a difference of opinion among those who have expressed views on the matter of increasing the annual dues of Society members by an amount to include the payment of Sections dues by those who reside in the respective Section territories. Several of the Sections or their Governing Committees favor amending the Constitution of the Society to this effect. There seems to be very little dissension from the feeling that in any event the dues of all the Sections should be collected through the office of the Society, concurrently with the annual dues of the parent organization.

Valuable Gear-Production Experience

MEMBERS who may be investigating means of manufacturing quiet-running transmission gears will find many interesting statements in the account of the Nov. 15 meeting of the Detroit Section which is printed on p. 514 of this issue of THE JOURNAL. This meeting brought out one of the most productive discussions of the gear-noise problem that has been held by the Society.

This meeting was the first of a series of monthly meetings of the Detroit Section that will be devoted especially to manufacturing problems and production methods. Over 200 men were in attendance, showing that the new step is appreciated by the factory executives. The Section will continue its usual monthly meetings devoted to design and research matters, these being held on the first Thursday of each month and the production meetings on the third Thursday.

Head-Lamp Illumination

MEMBERS of the Sections of the Society are making specific plans to cooperate locally with automobile clubs, dealers, car-owners' associations and municipal authorities with a view to improving head-lamp illumination conditions as much as possible, as soon as possible. The Metropolitan Section has designated J. W. Lord as the chairman of its committee. The Detroit Police Department maintains an adjusting station where an owner can have his car's head-lamps inspected as frequently as he desires. The Detroit Section reports that the main difficulty is to secure the interest of the car-owners in this matter. It is clear that a general effort should be made to keep the subject before the public. Incidentally, a Detroit ordinance requires that there be sufficient light to discern an object 100 ft. ahead of a car. In Massachusetts, the Registry Department designates head-lamp focusing stations, a card being given to the driver certifying that his equipment has been inspected. Secretary V. A. Nielsen, of the New England Section, is of the opinion that the assistance of citizens must be enlisted in an effort to remedy the bad conditions. There are obvious limitations on what can be done soon at the best. The full cooperation of all members of the Society locally is sought and they are requested to write the office of the Society expressing their views as to what means would be most effective.

What About Highways?

ARE the design and construction of highways keeping pace with the increased demands? However this question may be answered, it is certain that efforts are being made to bring the matter to a favorable issue.

An account of the recent session of the Advisory Board on Highway Research of the National Research Council will be found in this number of THE JOURNAL. From the discussion that took place at this session, it was obvious that the numerous cooperating organizations are making valuable contributions toward the betterment of present conditions and toward the solution of problems that have a bearing upon future requirements.

One of the most important of the highway researches now in progress in which the Society is cooperating is that sponsored by the Bureau of Public Roads; the plans were briefly outlined in the September issue of THE JOURNAL. This project, it is hoped, will bring forth new material relating to the effect of the vehicle on the road and vice versa. Furthermore, it is probable that the tests will reveal interesting facts concerning the destructive effect of the road upon itself as determined by the degree of smoothness of its surface. This is undoubtedly a much greater factor than has been recognized heretofore.

At the Nov. 9 meeting of the cooperative committee interested in this research, a report showing progress in preliminary work was presented. A steering committee of three was appointed to assist in deciding technical questions without necessitating the assembling of the entire committee. Dr. H. C. Dickinson, research manager of the Society, was chosen to act on this committee.

Spring-Movement and Vibration Study of Cars in Action

By T. J. Litle, Jr.[1]

Indiana Section Paper *Illustrated with* Drawings and Charts

PREVIOUS efforts to obtain comfortable riding-qualities for passenger-carrying automobiles are mentioned, and a device that combines a recording seismograph and a spring-action recorder is illustrated and described, since such a device is essential in conducting investigations of this character.

Methods governing the use of the device when studying spring action and chassis vibration are outlined, and the results obtained are presented graphically and discussed. Several unique features characterize these tests and are worthy of consideration, not only because of the results obtained thereby but as being good illustrations of what can be accomplished by substituting unusual and perhaps spectacular methods in special instances for ordinary practice that has failed to produce some desired result.

IN designing for comfortable riding in motor vehicles many difficult problems are met that have been with us many years and I believe are only partly solved. I will not refer to historical installations and drag you through the long development from the ox-cart to the automobile, but will simply refer to modern installations and the means that I have employed for determining and selecting the proper equipment.

The early automobiles traveled more slowly and the problem was not then so difficult; but now, with greatly increased speed and the more exacting demands of an educated public, we are compelled to pay greater attention to riding comfort. In addition, we have increased the touring range of our cars very much. It is common at present to hear of owners who travel 400 miles or more in a single day, with the larger cars; and they demand that they should be able to accomplish this without being temporarily crippled. The difficulty was that, when the more powerful engines were installed in cars to give them higher touring-speed, many builders resorted to the practice of using very much stiffer springs. This unquestionably made the cars harder-riding. Then came a period when the tops were given more headroom to increase the safety factor; to prevent the passenger from having his brains dashed out on the bows immediately above the seats.

The next logical step was the development of devices to restrain the violent rebound and excessive spring-action. Some of these devices were effective, but, at the same time, by simply retarding the spring action, had the effect of stiffening the springs, approaching nearer the goal that some engineers seemed to be aiming for, namely, to give the automobile all the riding advantages of a truck. In work of this character, which naturally is done in the experimental department and directed by the officials and by the entire engineering department, great differences of opinion exist. While in charge of such a department, I made up my mind that the old cut-and-try methods and the vague reports made concerning certain road-tests were perfectly foolish. Usually, a man forgets an impression received from this kind of a test, or becomes easily confused after going through several tests and then hopelessly muddled. All this goes to show that some kind of a measuring instrument and recording device is essential in such an investigation.

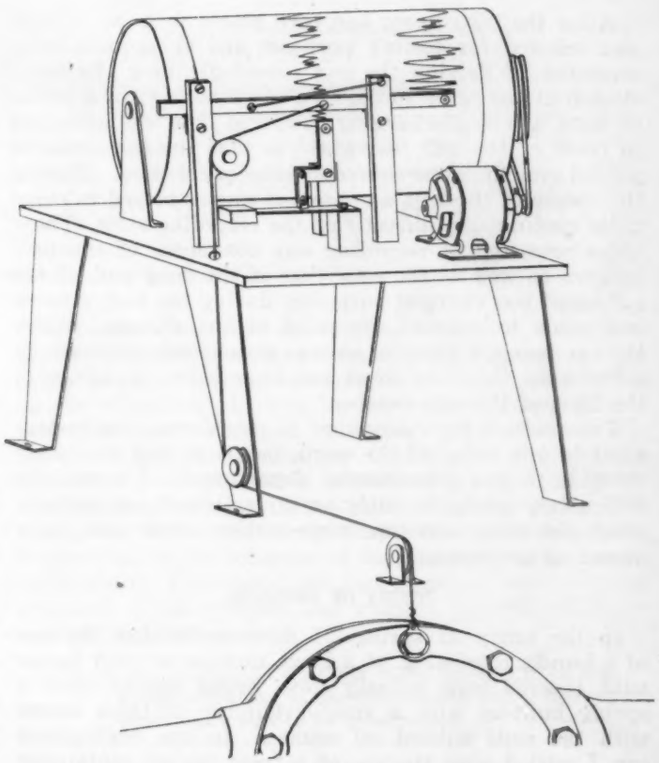

Fig. 1—Sketch of Recording Seismograph and Spring-Travel Deflector

Measuring and Recording Devices

After considerable preliminary work a device was constructed that combined a recording seismograph and a spring-action recorder; it is illustrated in Fig. 1. With this device the attachment is made with the axle by a cord running over pulleys to the instrument that rests upon the car floor. A reciprocating motion is imparted to a light sliding member that carries a stylus which makes a record on a moving strip of paper. The parts are all made extremely light. A thin braided-silk fishing-line was used, and the sliding member was made of a thin strip of spruce. Combined with a recording instrument, and making its record on the same sheet, was a seismograph consisting of a small weight attached to a thin leaf-spring that also was provided with a stylus. Typical

[1] M.S.A.E.—Chief engineer, Lincoln division, Ford Motor Co., Dearborn, Mich.

records are reproduced in Figs. 2 and 3. The "inches" noted at the left of the upper graph in each case indicate the extent of the spring deflection both above and below the normal resting position; that is, the actual relative motion between the axle and the chassis. The lower graph on each chart is the seismograph record that is made simultaneously with the spring-deflection record. The scale in inches at the left indicates the extent of motion of the weight on the end of the seismograph spring and roughly indicates the deviation in the body travel from a horizontal line.

Testing Methods

After the instrument had been placed in a car, a road was selected for testing purposes and subsequent tests consisted of driving the car repeatedly over the same stretch at the same speed. On the first trip, in a series of tests, a tube discharging powdered lime was arranged in front of the left rear-wheel so that the car could be guided over the same course in subsequent trips. During the course of the trip, an observer was employed to make notes continuously, directly on the recording strip. These notes consisted of recording any comments of the passengers as well as the condition of the road and, if the car speed was changed purposely during the test, a mark was made to indicate the point of the change. When the car bumped its axle, as was occasionally the case in a bad hole, this was noted and later led to a change in the form of the axle bumper.

The device I have described is not a precision instrument in any sense of the word, but it proved extremely valuable to the experimental department. I found the device very useful in studying the action of car springs, shock-absorbing devices, large-section tires and body mounting on chassis.

Study of Springs

In the study of springs, I determined that the use of a bundle consisting of a large number of thin leaves with tapered ends actually gave better results than a spring built-up with a smaller number of thick leaves with the ends dubbed off square. In one high-priced car, I settled upon the use of a front spring containing 14 leaves for regular production. The theory governing the use of a large number of spring leaves is that:

(1) Such a composite spring, built-up of a number of thin spring-leaves each having a different period, will be in itself dead-beat. In my opinion the car springs selected should contain as many thin leaves as it is practicable to use

(2) In addition to this period interference, we have the increased inter-leaf friction; and this is extremely desirable

(3) Better insulation against shock is provided; for, the more joints and the more oil-films in the shock-conducting path, the more efficient they will be as shock insulators

Another use for the recording device was in the design of the rubber bumper on the axle. When simply a square or cylindrical block of rubber was used, a rebounding thud when the body struck the bumper was very pronounced because the resistance in the bumper was built-up too rapidly, as noted on the graph that was taken during the test. Later, the form of this bumper was changed to one having a pointed section. In this form, the pressure at the time of impact, which resulted in a softer bump to the body, built-up more gradually than in a square bumper.

Shock-Absorbing Devices

The device is particularly valuable in the study of shock-absorbing devices, for such devices must be employed to prevent excessive rebounding. Many of the simple friction devices in use today unquestionably affect the rebound in the car but they have a great tendency to stiffen-up the ride. In some cases, they give very much the same effect as would be obtained if heavier springs were used.

Several of the hydraulic types of shock-absorber were studied also, and it was during this investigation that an important development occurred. It had been repeatedly observed that a dashpot used to restrain the rebound of the spring, in much the same manner that a dashpot is used on a door to prevent it from slamming, was very effective, particularly to enable the car to be driven rapidly over a rough road. But with all of these devices, it was noticed also that soft riding qualities over the city streets and the good concrete roads had been sacrificed. We decided that what was needed was a selective shock-absorber that would be cut-out of action automatically on the comparatively smooth roads and city streets but be brought into use on the rough roads. This would allow the use of the softest and most flexible springs. Such instruments were then designed. Subsequent tests proved that the conclusions drawn from the readings of the recording instrument, as shown in Figs. 2 and 3, were correct and the car equipped accordingly in production, in combination with the use of the car springs containing a bundle of many thin leaves, is remarkably easy-riding.

Study of Tires

The next important research made with the instrument was in connection with the study of large-section, low-air-pressure tires. This most interesting development promises to be of great commercial value. In this case, the primary record on the graph, the one indicating the relative action between the axle and the body, was very much diminished; that is, the unsprung mass made up of the axle, wheels and the like, had very much less reciprocation, the consequent steadying action on the passenger load being indicated by the recording seismograph. This is accounted for by the fact that the low-air-pressure, large-section tire does not bound over and is not elevated by the ordinary inequalities of the road surface, for it is a fact that small stones and ridges in the road actually imbed themselves in the softer tire. When considered purely from the standpoint of easy riding, these tires are a great success. Some problems remain to be solved in connection with their use on passenger cars. One of them is the increased steering effort required; I believe that will be solved in the near future by those who are specializing on steering-gear development.

In the use of these large tires considerably more bounding action in the front suspension occurred; and it was absolutely necessary to apply shock-absorbers. Some attempts were made to support the instrument on the seat cushions by strapping it in position, but this attempt to simulate the passenger and exactly record his riding sensations was not altogether successful because a passenger relaxes more or less while riding and the instrument of course does not have that faculty. I believe, however, that the instrument must be adapted eventually to record the riding qualities from the seat cushion, because cushion springs perform an extremely important function in producing easy riding. When the rebound

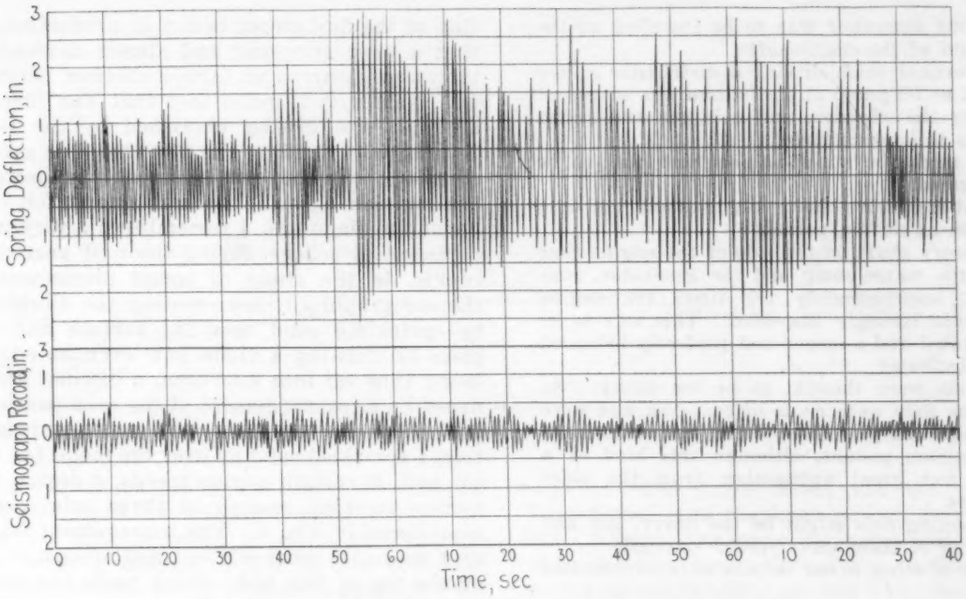

FIG. 2—VIBRATION CHART WITHOUT SHOCK-ABSORBERS

can be diminished greatly by efficient shock-absorbing devices, very much softer cushion-springs can be employed. I have thought many times that a cushion spring should unquestionably be built or provided with some rebounding dampener, but I know of nothing of the kind that has been suggested that is not either extremely foolish or unnecessarily trappy.

ENGINE VIBRATION

Engine vibration and its consequent effect on the chassis and body cannot be studied so well with this instrument. I have found a vibration tachometer to be extremely useful in this connection. It is of the type containing a series of vertically disposed spring leaves supported at the lower end and provided with small weights at the upper end, and is very effective. By simple calibration, the periods of each reed can be determined and, later, when the engine is running and one of the reeds is seen to break into vibration, a clue is thus given to the offending member in the engine that sets-up the vibration. During the early development of one powerplant an extremely annoying vibration was encountered and the tachometer reading led observers to suspect an out-of-balance condition due to too great reciprocating weights in the pistons and the rods. The management was extremely skeptical in this case, particularly as to the accuracy of such an apparently simple instrument. I attended one conference at which it was proposed to investigate the subject experimentally in various alternative ways.

(1) It was suggested that the vibration might be torsional vibration in the crankshaft, and a heavier crankshaft was to be constructed

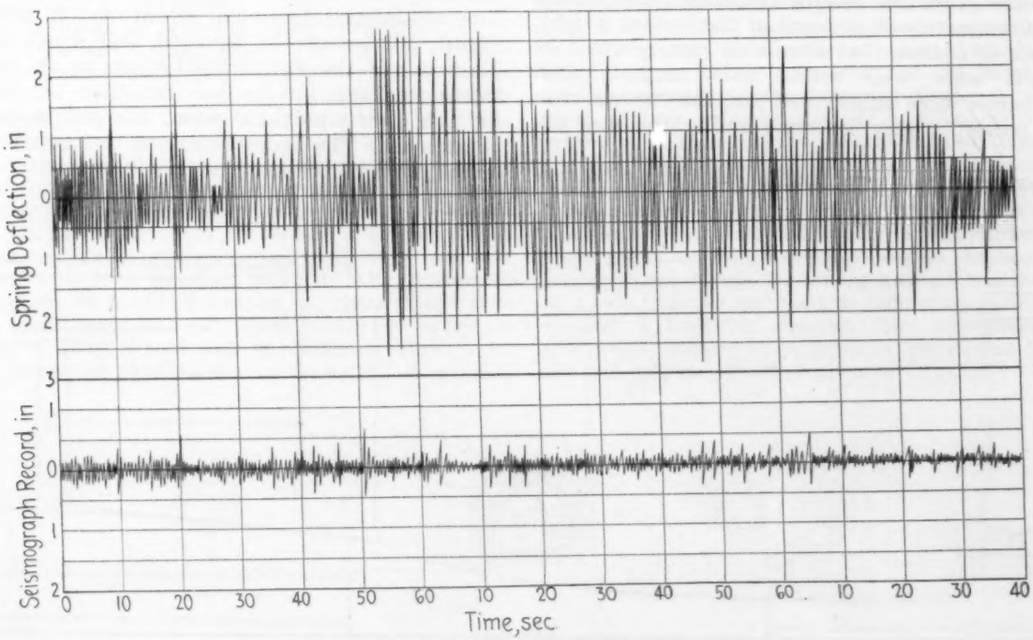

FIG. 3—VIBRATION CHART WITH SHOCK-ABSORBERS

(2) A vibration dampener was to be installed on the front end of the crankshaft
(3) A long vertical shaft driving a distributor at the top and an oil-pump at the bottom was suspected of being the offender, and a larger and stiffer one was to be constructed
(4) The fan might be out-of-balance and was to be investigated
(5) The front-end drive-chain might itself get into vibration at certain periods
(6) The accessory shaft on the side of the engine that drives the water-pump and the generator, running at approximately 1½ times the engine speed, was strongly suspected. This was to be investigated and a larger and perfectly balanced part substituted
(7) The pistons were thought to be too heavy. At that time they were made of cast-iron and were extremely heavy. These were to be replaced by aluminum pistons, although this kind of a change met great antagonism from the older engineers
(8) The connecting-rods might be too heavy, but any lightening of them was opposed strongly
(9) A number of other minor details were enumerated

Vibration Tests

To have determined experimentally just where the trouble lay by carrying out all the suggestions made at the conference would have consumed at least several weeks, and a quick decision was imperative. I had a very different plan. The next morning I had a closed car towed behind a test chassis and, riding in the rear car and letting in the clutch in high gear with the ignition cut-off, I noted that the vibration occurred at exactly the same periods and the same car-speeds as those at which it occurred when the engine was running under own power. I then disconnected one moving part after another from the engine until nothing was left in motion except the crankshaft, rods and pistons; but the vibration still existed, even after relieving the compression by completely removing the cylinder heads. This indicated clearly that the vibration was due to excessive reciprocating weight.

Weight was gradually removed uniformly from each piston until the vibration became negligible; the weight then was approximately 50 per cent of the former weight. It was known, of course, that aluminum pistons could be obtained that were well within this range. When aluminum pistons were substituted and the car was run by its own power, a very smooth-running job was obtained.

On another occasion, in connection with the construction of the first closed bodies in production, it was found that a very annoying and almost deafening drumming vibration occurred at certain distinct periods. This car was built with a metal roof that was indeed a work of art and was greatly cherished by the body designer. But, notwithstanding the fact that this great diaphragm member of the body was so strongly suspected by many of the engineering staff, the management felt very uncertain about the diagnosis. I remembered a very interesting experiment at college during the first year of the physics course, in the study of sound phenomena. That was the one graphically representing the vibration on a plate by sprinkling sand upon the surface and vibrating the plate by drawing a violin bow over its edge. The plate being thus set into vibration, a distinct design was produced by a rearrangement of the sand particles, the nodes and anti-nodes appearing in great contrast. Recalling this, I sprinkled sand all over the metal top on this closed car and, at certain engine speeds, a design was shown in a most striking manner at three points on the top, as reproduced in Fig. 4. The management was thus shown that we had a most efficient and sympathetic diaphragm on the top of this body which made the whole structure a wonderful resonator. It was suggested that the top be replaced immediately with a top of soft construction. However, this suggestion was not carried out immediately, as the management wished to know whether it would not be possible to dampen out the vibration at the anti-nodes. I built some experimental equipment consisting of a series of weights placed on the underside of the metal top at these points, by cut-and-try methods. The vibration was not absorbed until 55 lb. of weight had been applied to the top. To apply so much weight to a thin top would be absurd, of course. These weights, furthermore, had to be very rigidly attached; otherwise they themselves would set-up an additional rumble by impact. The foolish scheme of the hard-top construction was abandoned.

Still another interesting method of detecting vibration consists of placing a beaker of gasoline at various points along the top flange of the side-bar. Gasoline and not water must be employed for this purpose. When placed above the anti-nodes on the bar, the surface of the gasoline will break into violent vibration. In some cases the liquid will become so agitated that drops actually will jump out of the top of the beaker, as shown in Fig. 5. These locations on the bar can then be charted; they indicate clearly points at which the body bolts should not be attached. The body bolts must be located at the nodes or the parts of the bar that are in repose.

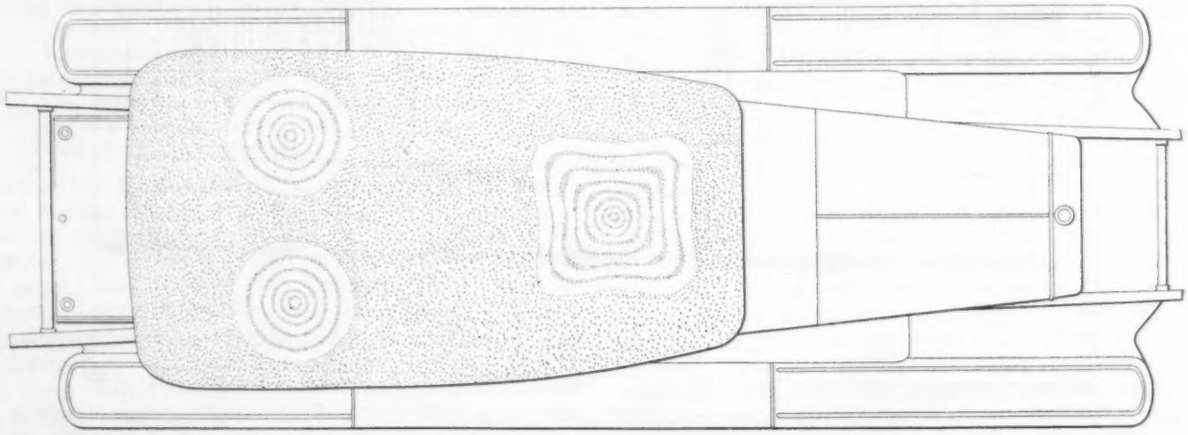

Fig. 4—Top View of a Closed Car Showing the Arrangement of the Sand Particles Due to Vibration

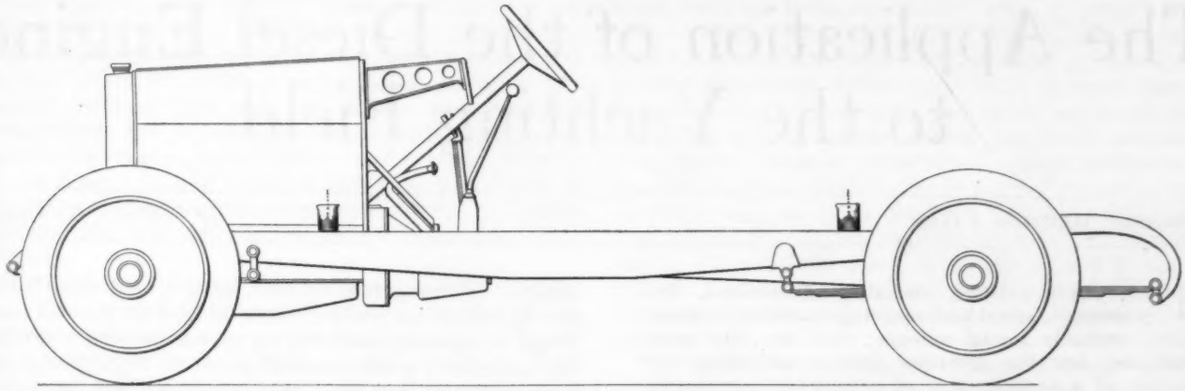

FIG. 5—SIDE VIEW OF THE CHASSIS SHOWING BEAKERS OF GASOLINE PLACED AT ANTI-NODES ON THE SIDE BAR

I mention these things merely to show that the engineer sometimes must be resourceful in selling his conclusions to the management. I believe that you engineers have many problems of like nature and that frequently you do not use enough common-sense in their solution. I am a great believer in "hob-nobbing" with the practical men in the shop, and have obtained many valuable ideas from them; but the men have to be "drawn-out," and considerable tact is required in doing this. I know that many engineers will disagree with me as to the way I approached the problem of the engine having excessive vibration, but I believe that spectacular, convincing methods are absolutely necessary at times to accomplish one's purpose.

MARKETING OF AGRICULTURAL PRODUCTS

I AM skeptical as to the possibilities of very great gains to the growers of wheat and cotton from the efforts to make a wholesale substitution of new cooperative marketing organizations for the existing machinery of the grain and cotton trades. An immense volume of capital is already employed in the existing machinery and to duplicate it would cost a vast amount. Whether agriculture can afford to build up elaborate and expensive machinery to do work that is already reasonably well done is a grave question. Another grave question is whether newcomers in the field could possibly duplicate the accumulated knowledge and experience of the men now in the trade except as they take over experts now employed in the trade.

In general, it would be well for those contemplating cooperative organization to study closely the existing machinery of the trade, and see how far it is necessary to duplicate it. In some cases, a cooperative might function for very limited purposes, taking care merely of certain local problems, and get much better service from reputable, established trade organizations for the rest of its business than it could possibly get through an amateur organization of its own. In other cases, the existing trade machinery may be so unsatisfactory that it is necessary to replace it entirely. But trade relations, trade knowledge, expert experience, personal contacts, good-will, long standing relations with businesses and organizations in foreign countries, all these things take time, money and thought to build. They should not be lightly thrown away. They should not be recklessly duplicated. It is better to use the existing machinery as far as possible.

One of the merits of the present tendency in cooperative marketing is that it has divorced itself largely from fraternal and political purposes and that it offers itself to the farmer as a business proposition, to study it in each case on its merits as a business proposition and not to allow himself to be stampeded by revival enthusiasm or political excitement into accepting it, unless a careful analysis of cold figures shows that it really will pay better than some slighter modification of existing practices.

The worst possible thing that could happen to the wheat industry is that organization of a holding pool of such financial power that it could successfully carry 200,000,000 bu. through the current crop year and into another crop year, with a concomitant increase in the price for wheat during the coming year. Production of wheat throughout the world would be enormously increased and the markets would be utterly swamped in the following year. A more probable result of such an attempt would be a temporary increase in price and holding back of American wheat from the world's markets, while Canada, Argentina and Australia marketed their supply, and then a collapse, before the year was over, in the holding movement, with greatly demoralized prices of American wheat that had lost its export market. The movement might last long enough to lead to increased planting of winter wheat during the coming autumn. It is characteristic of a policy of this sort that its temporary success necessarily involves a long-run disaster, since unorganized producers are greatly influenced by price in the volume of their planting and output.—B. M. Anderson, Jr., Chase National Bank.

The Application of the Diesel Engine to the Yachting Field

MOTORBOAT MEETING PAPER

By GEORGE A. COLLEY[1]

HULL characteristics, including dimensions, displacement, speed and seagoing qualities; cruising radius; probable annual mileage; first cost; and operating cost are the principal factors governing the selection of a suitable type of powerplant for marine usage. The paper considers them with reference to their special influence upon the application of the Diesel engine to yachts.

The question of making a Diesel installation is analyzed from an economic standpoint, and the relative operating costs for the various powers available for yacht usage are specified. Fuel consumption, reliability and other features of the Diesel are discussed, together with a brief mention of present Diesel installations and auxiliary equipment, the conclusion being that the Diesel engine offers great possibilities of advantages over those of other engines for yachts of the normal cruising type.

THE purpose of this paper is to cover the present application of the Diesel engine to the yachting field, and to show wherein such application can be used to the best advantage. Although the Diesel engine is by no means a "cure-all" for the yachtman's machinery problems, for certain classes of yacht, its installation offers advantages superior to those of any other form of propulsion, and definite qualifications usually determine the suitability of this type of powerplant for marine usage. The various factors affecting the selection of the type of power unit are (*a*) hull characteristics, including dimensions, displacement, speed and seagoing qualities; (*b*) crusing radius, (*c*) probable annual mileage, (*d*) first cost and (*e*) operating cost. Allied to all these points, of course, will be the type of service in which the yacht is to be used.

These determining features are interlocking to a greater or less extent in each design, and each installation is a separate problem to be judged on its own merits. Diesel equipment available up to the present time limits the hull size to a minimum of about 60 ft., although there is every indication that this minimum will be reduced. The upper limit of size has not as yet been reached as power units large enough to handle the maximum demands of the present-day yacht-owner are available.

Speed probably is one of the first characteristics that must be considered. When a speed of over 12 knots is desired in the smaller seagoing yachts, and more than say 16 knots in the larger ones, the use of Diesel engines is usually not advisable. It is then wise to go to the lighter, more compact gasoline units of greater power, to high-speed reciprocating steam-engines or to turbine units with water-tube boilers. The speeds noted above, however, are ample for all-round cruisers of moderate dimensions, the larger seagoing yachts or the full-powered auxiliary. The reasons for the above speed limitations are that the weights per horsepower, ranging from 85 to 190 lb. depending on the engines selected, raise the total hull-weight to such an extent that greater speeds are not desirable nor in most cases possible.

TABLE 1—RELATIVE FUEL-CONSUMPTION AND COST

Type of Prime-Mover	Fuel Used	Average Fuel Cost	Fuel Consumption per B.Hp-Hr.	Fuel Cost per Hr.	Fuel Cost per 1000 Hp-Hr.
Diesel Engine	Fuel Oil 22 to 32 deg. Baumé	$0.050 per gal.	0.450 lb. 0.060 gal.	$0.00300	$3.00
Gasoline Engine	Gasoline	$0.230 per gal.	0.800 lb. 0.114 gal.	$0.02620	$26.24
Steam: Oil-Fired Boilers Triple Expansion Reciprocating Engines	Fuel Oil 14 to 24 deg. Baumé	$0.040 per gal.	1.300 lb. 0.170 gal.	$0.00680	$6.80
Steam: Coal-Fired Boilers Triple Expansion Reciprocating Engines	Coal	$8.00 per ton $0.004 per lb.	1.800 lb.	$0.00720	$7.20
Steam: Oil-Fired Boilers Geared Turbines	Fuel Oil 14 to 24 deg. Baumé	$0.040 per gal.	1.200 lb. 0.156 gal.	$0.00624	$6.24

Likewise the greater over-all engine dimensions have a similar limiting effect when compared with high-speed gasoline-engine installations.

COSTS

From an economic standpoint the items of first cost, operating period per season and operating cost, determine whether the Diesel installation should be preferred. The relative operating figures for the various powers available for yacht use are given in Table 1.

Lubrication charges against the Diesel engine average about 1 gal. per 1000 hp-hr., which is about 25 per cent less than the average lubricant consumption by gasoline

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engines. Lubrication costs on steam installations are low, but are more than offset by the cost of stand-by charges, which in some cases run up to 25 per cent of the total fuel charges. With present Diesel-engine prices averaging between $75 and $85 per hp. and gasoline-engine prices, for engines capable of operating in the same service, ranging from $35 to $50 per hp., fuel oil at 5 cents per gal. and gasoline at 23 cents per gal., it is possible to determine the minimum number of operating hours that will warrant an owner installing Diesel machinery.

Assuming certain fixed charges against each installation per year, such as interest on initial investment, depreciation, insurance and maintenance, which will total about 20 per cent of the initial cost, and adding to these items the operating charges per year with varying hours of operation, a true comparison can be made. Calculations of this nature have been worked out on several installations during the past 2 years and show that, as between the gasoline and the Diesel engine, the maximum economical operating period for the gasoline unit is from 300 to 500 hr. per season. With steam units, the same method of comparison can be used and, figured entirely from the standpoint of economy, the cruising period necessary to warrant Diesel installation would extend to between 750 and 850 hr.

Fuel Consumption

From the fuel-consumption comparison given in Table 1 it will be seen that, for a given cruising-radius, the gasoline-driven yacht requires practically twice the weight of fuel necessary for the Diesel-driven yacht; that the oil-fired steam unit requires about three times and the coal-fired steam unit more than four times the weight of fuel. In the case of the gasoline yacht, this additional weight feature practically balances the saving in engine weight over that of the Diesel unit. The cubic capacity of the additional fuel also tends to balance the greater size of the Diesel engine.

As against the steam installation, however, the difference in weight and in volume is greatly in favor of the Diesel engine. Steam-operated craft require a large quantity of boiler feed-water which, of course, is entirely eliminated from the Diesel unit. This allows the designer to either decrease the displacement or increase the fuel-storage and, correspondingly, the cruising-radius. Steam installations, in addition, operate under the handicap of a much greater engine-room crew. Compared with a coal-fired boiler job, firemen, coal-passers and water-tenders are eliminated, with a corresponding decrease in the accommodation requirements, amount of food and the like. Compared with oil-fired boilers, water-tenders and firemen are eliminated, with a similar but not so great a saving.

If the owner wishes to take full advantage of the possibility of increasing the cruising-radius when comparing the steam and Diesel installations he can add from 200 to 300 per cent to the mileage without increasing the displacement, depending on the unit selected for comparison. As an example of the increased accommodation obtainable, a Diesel-powered yacht of 180-ft. overall length has practically the same owner's accommodations as a steam yacht of 225-ft. length.

Reliability

Formerly the matter of reliability was the bugbear of the Diesel engineer, but this has now been settled definitely. At present on the east and the west coasts of the United States some 25 or more Diesel installations, ranging from the smaller type of cruiser to seagoing yachts 180 to 200 ft. in length, are in service. These installations vary considerably in detail, some being full-powered, others auxiliary; in some cases, the Diesel-electric drive is used. All these yachts are operating with entire success, which has been attained by cooperation between yachtsmen, naval architects and engine builders. Reliability, in straight running and in maneuvering, has been obtained through careful design and installation of the main engines and of the auxiliaries. By carefully checking-up the details of the main engine, foundations, shafting and the like, vibration has been reduced to such an extent that it is no longer a factor.

The modern Diesel engine is accessible, easy of repair, cleanly and economical as regards wear on moving parts. Standardization of parts enables spares to be carried for quick replacement with a minimum of expense and time loss. With the cooperation of the American Bureau of Shipping and the insurance companies, the insurance rates are better than on gasoline installations and as low, if not better, than on steam installations.

Many of the yachts are used as ferries between New York City and Newport, R. I., Fisher's Island and other shore points and make several round-trips a week. Their ability to get under way on extremely short notice, coupled with the fact that one fueling will suffice for half a season's operation, is an obvious added advantage. Eliminating the necessity for frequent fueling, with its attendant objections, enables the yacht to be kept in shipshape condition with a considerable reduction in labor and expense. The annoyance and delay caused by coaling, ash-removal and the like are completely dispensed with, and wear and tear are reduced accordingly.

Present Diesel Installations

Three general types of Diesel installation are used at present: (*a*) the low-power installation on the smaller cruisers and auxiliaries where the engines are not directly reversible, and where maneuvering is accomplished by a clutch and reverse gear; (*b*) the direct-reversible installation where all maneuvering is done by compressed air, the engines being fitted with a double set of cams, one for ahead and the other for astern operation; and (*c*) the Diesel-electric drive, in which one or more Diesel engines provide the necessary power for generating electrical energy that, in turn, is transmitted to the driving motor or motors. In the last case the main generators are run continuously and all maneuvering and control is handled electrically. For certain installations in which the space available for machinery is divided-up, or where conditions require a propeller speed beyond the limits of the direct-drive Diesel or, in fact, for special installation of any sort, it is possible to obtain results with the electric drive that can be obtained in no other way. An example of this is the schooner yacht Alcyone. This vessel is equipped with a 350-shaft-hp. installation, consisting of two generating-units and one double-armature motor, in a space that would not have permitted a direct Diesel installation of over 250 hp. at an efficient propeller speed. The control is extremely flexible, especially at low speeds, and this point is one of the chief advantages of this type of drive.

Auxiliary Diesel Equipment

The importance of the auxiliary equipment in a Diesel installation cannot be overestimated. It is absolutely essential to the proper operation of the plant to have the auxiliaries balanced adequately to perform their

various functions. The average installation, in addition to the main propeller-equipment, consists of a suitable hand-started auxiliary capable of furnishing sufficient power to operate either the main or the auxiliary air-compressor, thus furnishing air for starting or in case the air has been released on account of repairs or alterations to the air lines, tanks and the like. The air-compressor units can be driven either electrically or directly from a small engine. Electrical operation usually is favored, for with this method the small generator-unit can be used for emergency lighting. In small installations, one or two generating-units of 5 to 10-kw. capacity will take care of all the auxiliary power requirements. Usually units of this size are equipped to use both gasoline and kerosene fuel.

In the larger yachts, where an electrically driven ice-machine, a power-windlass, a boat-hoist, maneuvering-compressors and the like are to be handled, the installation of a larger generator-unit, to operate on the same fuel as that used by the main engine, is usually advisable. In some cases this is done in duplicate. Units of from 10 to 20-kw. capacity can be obtained that operate on the Leissner or some similiar principle and, for capacities from 20 kw. up, full Diesel units are available. Generally the air-compressors are in duplicate in the large installations, which naturally makes for reliability. The air-compressor units on the yacht Dolphin, with the air bottles grouped above, afford an instance of the possibilities of a neat and an accessible arrangement. In the Nourmahal's engine room, the circulating-water and the lubricating-oil pumps are attached to the main engines. This is conceded to be good practice within the power requirements of the yachting field, although in the larger commercial installations independently driven pumps are the usual arrangement. In this case, of course, they should be in duplicate.

In conclusion, when the yacht under consideration is of the normal cruising type and of moderate speed-requirements, in which the owner expects to cruise more than 400 hr. or more than 4000 nautical miles per year and wishes the maximum accommodation with the minimum operating cost, the Diesel engine offers possibilities in economy, cruising-radius and reliability that cannot be approached by any other form of prime-mover.

THE DISCUSSION

QUESTION:—Referring to electric-drive propulsion, at what speed is the propeller required to run?

GEORGE A. COLLEY:—At any speed desired. You should determine the best speed for the job, say 100, 175, 350 r.p.m. or whatever it may be. The electric motor is designed for a certain speed and will operate from that rate down through the intermediate speeds to zero. You control the number of revolutions per minute of the motor definitely, as you usually have from 25 to 35 points between full power and no power, and between full speed and no speed, at which you can operate it.

C. D. LEFEVRE:—Does the Diesel engine operate at a constant speed?

MR. COLLEY:—Diesel engines are designed to operate at a constant speed at all times, when used in connection with the electric drive. The usual practice is to mount the controlling exciters on the end of the generator shaft; the control station can be located anywhere you wish.

L. M. WOOLSON:—What are the limitations on size of small Diesel engines? One engine operating on the Diesel principle at the Motorboat Show had a 2¾-in. bore. Why have we not more Diesels with 2¾-in bore?

MR. COLLEY:—We have built a number of engines with 5¾-in. bore, which is a very small engine, with air-blast injection. In the semi-Diesel engine, or the surface-ignition engine and, as some people call the other type, the preignition engine, as in the Leissner method, the engines can run in fairly small sizes. One small engine of about 7½ hp. per cylinder, from what I have seen of it, operates very well. I see no reason why such engines cannot be applied to the smaller boats. They have not been in operation long but I have no doubt that, within a year or two, we shall see many boats of the heavy-duty type, not high-speed boats, but comfortable cruisers in sizes considerably smaller than those mentioned previously.

H. W. SLAUSON:—Is the electrically driven boat controlled from the bridge or by signals to the engine room?

MR. COLLEY:—It can be controlled either way.

MR. SLAUSON:—Will the governors take care of variable loads on the engines?

MR. COLLEY:—The governors will take care of them under all conditions. We have recently completed a test on some 10 engines for the Coast Artillery Corps, in which the variation was kept down to from 1½ to 2 per cent under varying load conditions, which is better than is required ordinarily. Usually, the electric companies do not need such close regulation; 3 to 4 per cent generally is sufficient.

MR. LEFEVRE:—How close is the speed-control of the motor?

MR. COLLEY:—About the same.

MR. LEFEVRE:—What is the advantage of the electric drive, as compared with the Diesel, in direct maneuvering?

MR. COLLEY:—I think the direct drive is applicable in a majority of cases. The first electric-drive installation we had was in a schooner that did not have room enough to put the motor in the engine room. We could not get the shaft through from the engine room aft to the stern. We put the motor away aft, just ahead of the stern post, alongside of the center line, and the engine was forward in the hold. This arrangement was warranted by the conditions. In certain types of boat, a great quantity of power is used for other services than propulsion. This does not apply to the yachting field. In other installations where pumps or other power units require a large proportion of the total power generated, one of the generator-units may be required for this service. I think it can be said definitely that, except in special cases, the direct-drive type of yacht like that of the Dolphin or the Nourmahal, is the logical installation. The engine units are efficient, and give good propeller efficiencies at the speeds used. When better propeller results are needed, as in very slow boats where propeller speeds of about 90 r.p.m. are required, the electric drive will give much better results. When everything is normal I should say that the straight Diesel drive can be used.

QUESTION:—Has any experimental work been done with solid injection?

MR. COLLEY:—Yes.

C. F. SCOTT:—What is the highest speed on direct Diesel drive that is now considered economical for propeller efficiency in cruisers?

MR. COLLEY:—About 500 r.p.m., depending on the type of boat. We would not turn the propeller on an 800-ton boat like the Ohio at 500 r.p.m.; that would be much to high. About 250 or 300 r.p.m. would be as high as we ought to go. Practice leans toward that

(*Concluded on p.* 501)

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Motor-Vehicle Wheel-Alignment

By JOHN F. DUBY[1]

NEW ENGLAND SECTION PAPER *Illustrated with* DRAWINGS

SINCE accurate wheel-alignment is of much greater importance than has been realized generally and because so much confusion existed regarding proper methods of securing it, the author explains a method for obtaining correct alignment that will insure easy steering and cause the least amount of tire wear.

Correct wheel-alignment is defined and the differences between front-wheel and rear-wheel alignment-requirements are stated. "Toe-in" and "camber" are analyzed, their requisite values are discussed and the manner of determining them is explained. Axle-tilt and wheel-wabble are considered also in their relation to the subject, and a summary is given of the proper procedure to secure correct wheel-alignment.

ACCURATE alignment of the wheels of an automobile is of great importance. When it is realized that the cost of operating a car can be reduced by 5 to 50 per cent merely by making a slight adjustment that is already provided for on the tie-rod, it is difficult to understand why the subject of wheel-alignment has been so neglected. I visited not long ago nearly all of the automobile plants in Detroit, Flint, Pontiac, Toledo and Cleveland. I found that much confusion existed with regard to the subject. Until recently there has been no standard to follow.

After having investigated wheel-alignment very thoroughly, I will endeavor to give a logical answer to such questions as may be raised regarding the subject. Although different sizes and types of car cause varying conditions, I will give a short, easy method of calculating and allowing for the correct wheel-setting for all cars, so as to insure good steering and cause the least possible amount of tire wear. Contrary to the opinion of many, it is not necessary to sacrifice the tires to obtain good steering. A tire can be ruined much sooner by misalignment than it can by under-inflation; yet many drivers of cars use the utmost care in keeping their tires pumped-up to the proper pressure and pay practically no attention to the alignment of the wheels.

Some factors do not come directly under the heading of wheel-alignment, but they are connected with it so closely that we cannot treat the subject thoroughly without including them. For instance, wheel-alignment is affected seriously by axles, tie-rods, king-pins, radius-rods, steering-arms and the steering-gear. Even the spring-suspension plays a much more important part than most people realize, as will be shown later.

CORRECT WHEEL-ALIGNMENT

Let us first determine just what constitutes correct wheel-alignment. To some it might appear that the two front-wheels should be parallel, the two rear-wheels parallel and each rear wheel directly in line with the front wheel on the same side. This would place the four wheels in such a way that a straight line could be drawn directly through the center of the two right-hand wheels, another line could be drawn through the center of the two left-hand wheels, and the two lines would be exactly parallel. If it were not for other conditions, this arrangement, which is shown in Fig. 1, would be ideal and would allow all four wheels to roll freely and cause the least possible amount of friction.

Rear wheels are adjusted very much as one would naturally expect. They should be parallel in every way; that is, each rear-wheel should revolve in a perfectly true circle, the two rear-wheels should be the same distance apart at the front and the back and also at the top and the bottom, and the axle should be at right angles with a line drawn through the center of the frame from front to rear.

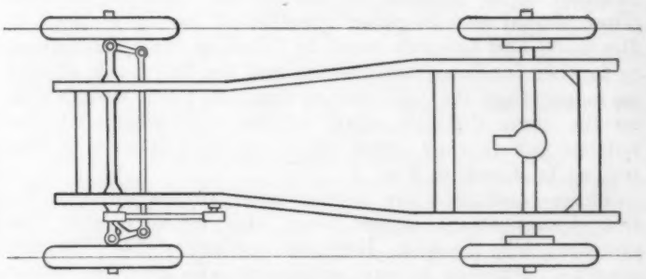

FIG. 1—DIAGRAM SHOWING WHAT APPARENTLY IS CORRECT WHEEL-ALIGNMENT

If the rear axle is not at right angles with the frame and the front-wheels are set perfectly straight, the car will go around in a circle instead of straight ahead. This tendency can be overcome by turning the front-wheels in the same direction that the rear-wheels are pointed. This will cause the car to travel in a straight line, but the rear-wheels will travel off to one side instead of following the front-wheels.

On some cars the rear axle is held in position by the rear springs. With this construction, it can be seen readily, it is necessary to have the two rear springs of exactly the same length so as to hold the axle square with the frame. If the spring-clips should become loose and allow one side of the axle to move backward or forward, the axle would not be square with the frame and, consequently, would be out-of-line. Another type of construction has radius-rods that hold the rear axle in the proper relation to the frame. These rods are provided with adjustments by which either or both sides of the rear axle can be moved forward or backward. On this type, it is necessary to have both radius-rods adjusted to exactly the same length. The rear axle and the drive-shaft housing on another type are bolted together and make a T-shape unit. In some types, this construction is reenforced by having the springs act as radius-rods but, on other types, the springs are hung in such a way as to give free action to the rear axle; in the latter case the drive-shaft housing is depended upon to hold the rear axle in the proper alignment. A severe bump on either wheel might bend the drive-shaft housing; in this case, the rear wheels would be parallel with each other but the axle would not be at right angles with the frame.

[1] John F. Duby Co., Mattapan, Mass.

On still another type, the rear axle is held in position by the drive-shaft housing re-enforced by two adjustable brace-rods that extend from a point near the universal-joint to the two outer ends of the rear-axle housing. If these rods are too long, they push the ends of the axle housing back, while the drive-shaft housing holds the center forward. This bows the rear axle in such a way as to cause the wheels to toe-out. If these rods are too short, they pull the axle housing forward and this causes the wheels to toe-in. Therefore, with this type of construction, it is necessary not only that the two brace-rods be adjusted to exactly the same length, but that both brace-rods be of exactly the right length. This explanation shows that, for the rear wheels, it is simply a matter of keeping the rear axle at right angles with the frame and the rear wheels in perfect alignment with each other.

Front-Wheel Alignment

An entirely different condition is presented by the front wheels. As one writer very appropriately states it: "The front wheels to be in-line must be out-of-line." That is, the front wheels must be set so that they are slightly closer together at the bottom than at the top. They should also be closer together at the front than at the back, and the axle must be tilted so that the bottom is farther forward than the top and the front axle should be longer than the rear axle so that the front wheels will be the same distance apart as the rear wheels at the bottom but farther apart than the rear wheels at the top, as is shown in Fig. 2.

These conditions are agreed upon almost universally, but disagreement arises over the reasons and the amounts to be allowed. Different engineers give different reasons. Strange to say, engineers who give the same reasons differ as to the correct amounts to be allowed. It appears that we should decide upon a standard.

In the days of the horse-drawn carriage, the front axle was a solid bar running from wheel to wheel and extending through the center of each hub. This bar was attached to the chassis of the carriage by a large bolt in the center called the king-pin. The shafts, or the pole, were connected directly to the axle. When turned they caused the entire front axle to turn and carry the wheels with it; thus, the vehicle could turn a corner without any slippage of the wheels. But it was found that this method was not practicable in automobile construction; so, the front axle was divided into three parts, the axle and two spindles. Each wheel revolves on a separate spindle pivoted to the end of the axle proper by a king-pin; thus, the front wheels can be turned so as to go around a corner while the axle remains rigid.

Each spindle is supplied with an arm that extends laterally, called a spindle-arm. Each of the two wheels could be steered in different directions by these arms except for a connecting link called a tie-rod. This rod, when shortened, will bring the wheels closer together at the back; when lengthened, it will spread the wheels farther apart at the back. But, when it is adjusted properly, it will hold each wheel in the correct alignment with its mate. On some cars the tie-rod is placed in front of the axle; in this case shortening the tie-rod brings the wheels closer together in front.

In automobile design, instead of having one straight bar for a front axle, a number of parts constitute the front-axle assembly. This has been done to bring the king-pins as close as possible to the wheels, and thereby decreases the tendency for the car to turn from one side to the other as the wheels strike small obstructions on the road.

In the former carriage construction, if the carriage were pushed through sand or mud the axle would tend to bend backward at each end; this would bow the center of the axle forward and cause the wheels to toe-out. This condition was counteracted in carriage construction by the fact that the shafts, or the pole, were always attached to the axle at two points, each about midway between the king-pin and one of the front wheels. Since the power was applied at these two points instead of at the center, this prevented the axle from bending backward at each end.

In automobile construction, even with the king-pins set close to the wheels, a slight tendency for each spindle to bend backward as the car is being propelled forward still exists and, if the wheels were set perfectly parallel when the car was standing still, they would immediately toe-out when the car was started forward. This toeing-out would increase with the speed of the car, or as the road conditions became such as to cause more resistance to the forward movement of the front wheels. Right here is one of the principal reasons for toeing-in the front wheels. But this tendency to bend backward varies with different types of construction.

Camber

Other factors have a direct bearing on the amount of toe-in required; one of these is "camber." An understanding of camber is absolutely necessary when determining the correct amount of toe-in. In carriage construction it was common practice to arch or crown the axles. The bowing-up in the center of a solid bar that extended through the hubs of the wheels caused the wheels to be closer together at the bottom. This was commonly called camber.

In automobile construction also, the wheels are set closer together at the bottom than at the top, but it is done in an entirely different way and for a different purpose. Instead of cambering the axle, the spindles are designed so that they are not at right angles with the king-pins. This gives the same effect as actual camber, and we will continue to use that term.

The principal reason for camber is to bring the wheels into contact with the road at a point directly under the center of the king-pins as nearly as that is possible; this still further decreases the tendency for the spindles to bend backward as the car is being driven forward. This would decrease greatly the necessity for toeing-in except for the fact that setting the wheels at this angle causes each wheel to act as a cone where it comes into contact with the road and the tendency of a cone is to roll around in a circle. Therefore, this very cambering, or the setting of the wheels closer together at the bottom, necessitates toeing-in in itself; so, as the necessity for toe-in due to camber increases, the necessity for toe-in due to the spindles bending backward decreases. One just offsets the other, and the necessity for toe-in remains exactly the same.

Another reason for both toe-in and camber is as follows: The weight of the car is carried on the spindles, the spindles are held in position by the king-pins and the weight of the car tends to press outward at the bottom and inward at the top of the king-pins; this causes a binding strain on the king-pin bushings. By bringing the wheels into contact with the road at a point nearer to a direct line with the center of the king-pins, this tendency is decreased. It is decreased still further by setting the wheels closer together at the front, which causes the wheels to pull-in at the bottom, due to the tendency for the wheels to roll toward the center. This

makes a car easy to steer. If the wheels were toeing-out in addition to the effect due to the weight of the car, the wheels would be pulling outward at the bottom; this would increase the binding strain and make a car hard to steer.

We now have several good reasons for both toe-in and camber, but we must remember that a greater amount of camber does not necessarily require a greater amount of toe-in; because, as the camber increases, the tendency for the wheels to spread at the front decreases.

Other Factors Affecting Toe-In

Other factors materially affect the amount of toe-in. First, the amount of pressure required to spring the steering connections. A car with stiff spindle-arms will require less toe-in than one on which the wheels can be sprung outward easily at the front. Second, the size of the wheels. Large wheels require more toe-in than small wheels. Third, the size of the section of the tire. A 32 x 4½-in. tire requires more toe-in than a 32 x 3½-in. tire. Fourth, the point at which the tests are made. If a car were tested for toe-in by taking the readings from the tires and it showed ¼-in. toe-in, the same car tested from the felloes would show considerably less than ¼-in. toe-in because the front and back readings would be taken much closer together.

Method Employed

It might appear necessary that each service-station employ an engineer to determine the amount of toe-in and camber required on each car, but this is not the case. I offer a quick, easy method of eliminating all this confusion, so that it is not even necessary to use a chart showing the amount of toe-in required on different cars. This method takes care of all these varying conditions, treats all cars alike and yet actually gives to each different type the correct amount of toe-in without any special allowances.

Regarding the variation in the stiffness of the different spindle-arms, by pressing outward on the front of both front wheels, those cars that are equipped with stiff spindle-arms and tie-rods will not be affected but, if the car is equipped with parts that are easily sprung, the wheels will be pushed outward at the front and the friction of the tires will prevent them from coming completely back to their normal position, varying in exact accordance with the amount that those parts can be sprung. If the wheels are tested for toe-in in this position, they actually will be given more toe-in than what is shown on the gage, thereby compensating automatically for that springy condition and making it possible to give the same allowance for toe-in on all cars.

As to the size of the wheels, if all the readings were taken at the center of the wheels, a different allowance would need to be made for each different size of wheel but, by taking all readings at a distance of 9 in. from the floor, the large wheels will be tested farther below their centers than the small ones and, if the same allowance is given on the gage, the large wheels automatically will be given more toe-in than the small ones, thereby again making one allowance for toe-in on all sizes of wheel.

If some cars were tested from the felloes and some from the tires, a different allowance would be necessary and, on wire wheels and disc wheels, the readings must be taken from the tires because there are no felloes. Therefore, I recommend taking all readings from the tires and not from the felloes. This gives one method

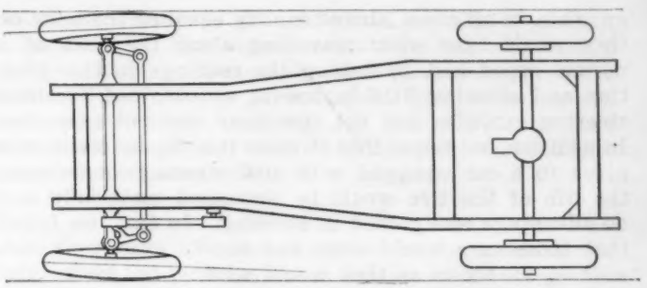

Fig. 2—Diagram Showing the Relative Wheel-Positions That Have Been Found To Be Satisfactory

of testing on all cars, again making it possible to give one allowance for toe-in on all cars.

The measurement from wheel to wheel should be taken from the tire at the front, 9 in. from the floor. The car should then be moved forward far enough so that the second reading can be taken from the same identical part of the tire 9 in. from the floor at the back. This eliminates any possible chance of getting an inaccurate reading due to a lump on the tire, a crooked rim or a crooked wheel. If the readings were taken from two different points on the tire or the wheel, this would be very likely to give an inaccurate reading for spindle and tie-rod adjustment due to a slight inaccuracy in the tire or to a crooked felloe, rim or wheel; the felloes very rarely run perfectly true, even on new cars.

As to a 32 x 4½-in. wheel requiring more toe-in than a 32 x 3½-in. wheel, it will be found that if the readings are taken from the part of the tire that offers a flat surface for the end of the gage or measuring apparatus, the two readings will be taken closer together on the 32 x 4½-in. tire than they will on the 32 x 3½-in. tire, thereby automatically giving more toe-in to the 4½-in. tire than to the 3½-in. one, again making it possible to give the same allowance for toe-in on all cars.

We now have a method by which all of these varying conditions are automatically taken care of and we are able to give the same allowance for toe-in on all cars. We will next determine just what that amount of toe-in should be.

Amount of Toe-In

After taking this matter up with the automobile and the tire companies we still lacked sufficient information to be able to say definitely just what the correct amount of toe-in should be. One company would specify ⅜-in. toe-in and another company, using practically the same construction and the same size of wheel, would say ⅛-in. toe-in. We then proceeded to try out each of the recommendations. After much experimenting, we finally concluded that no definite amount of toe-in could be stated unless we could compensate in some way for the amount the wheels would spread at the front while traveling on the road.

By attaching an apparatus that would give the exact setting of the wheels at any speed on the road, we found that some makes of car, having an initial toe-in of ¼ in. and no play in the bushings, would be running perfectly straight at 25 m.p.h. On other makes of car having an initial toe-in of ¼ in., we found that they would still remain at almost exactly ¼-in. toe-in at 25 m.p.h. We found also that, by pressing outward on the front of both front wheels, we could spring the wheels apart on some cars as much as ½ in., but that the friction of the tires on the floor would prevent them from coming completely back to their normal position after they were let

go; this, in all cases, almost exactly equalled the position they would take when travelling along the road at a normal speed and, by taking the readings in this position and allowing 3/16-in. toe-in, we obtained excellent steering qualities and the tire wear was not excessive. In addition, we found that if more than ¼-in. toe-in was given to a car equipped with stiff steering-connections, the life of the tire would be decreased materially and no advantage was gained in steering. In fact, we found that those cars would steer and handle exactly as well with ⅛-in. toe-in as they would with ¼-in. toe-in, and that this applied to every size and type of car tested. Therefore, anywhere from ⅛ to ¼-in. toe-in would be the correct amount, provided, however, that the readings were taken from the tires at 9 in. from the floor.

To summarize, if you will press outward on the front of the front wheels, then let go of them and allow them to come back as nearly to their normal position as the friction of the tires will permit, then take the reading from wheel to wheel, on the tires, 9 in. from the floor, then move the car forward until that same part of the tire arrives at a position back of the axle, 9 in. from the floor, and then take the second reading from wheel to wheel, the second reading should be 3/16-in. greater than the first reading, with a tolerance of 1/16-in. either way. This means from ⅛ to ¼-in. toe-in on all cars.

In some designs, the king-pin is set out into the hub so that, with a slight amount of camber, the wheels actually come into contact with the road at a point directly in line with the center of the king-pins. In this case, obstructions on the road or heavy mud or sand have no tendency to bend the spindles backward. If all cars were of this design, the amount of toe-in could be decreased somewhat, but a slight tendency for the wheels to spread apart at the front would still remain; hence, 3/16-in. toe-in is not too much, even for this type of construction.

Amount of Camber

The amount of camber is not a vital factor. A car will steer perfectly well with either 1 or 3 deg. of camber. In fact, different engineers allow anywhere from 0 to 4 deg. of camber and no appreciable difference in the steering or handling of the car is apparent; but, as the amount of camber increases beyond 2 deg., it begins to affect the wear of the tires. Therefore, I say that 2 deg. is sufficient.

All that is necessary to test for camber is to suspend a plumb line from the outside of the tire at the top and measure the distance from the line to the tire at the bottom. The line should be hung so that it will pass the center of the wheel at a point 4 in. in front of the hub. This is done so that the measurement will not be taken from that part of the tire which is flattened out on the floor by the weight of the car. When wheels are tested in this manner, 2 deg. of camber on a 34 x 4-in. tire will show exactly 1 in. from the plumb line to the tire on each wheel at the lower end. Larger wheels, with the same degree of camber, would show more; smaller wheels would show less, but the difference would be very slight.

The method of testing rear wheels is the same as that of testing the front, except that the first reading should be taken from the tires at the back; then, the car should be moved backward instead of forward. Of course, no pressing outward of the wheels is necessary. The rear wheels should have no toe-in and no camber; consequently, the height at which the readings are taken on rear wheels is not important.

Testing Instruments

While no particular gage has been mentioned for testing toe-in, I believe the one best adapted to test in this way is the one that is placed between the wheels at the front and is held in position by a spiral spring that presses each end of the gage firmly against the tires, as shown in Fig. 3, the pendant chains indicating the proper height from the floor. The pointer is set at zero. The gage is then left in position while the car is being moved forward and is automatically carried to the position for the second reading. The pendant chains indicate when the car has been moved far enough to reach the proper height at the back of the wheels. The pointer will then register the exact amount of toe-in without necessitating any calculations; consequently, no possible chance of making a mistake is present.

The method of testing to see if the rear axle is at right angles with the frame is to measure from a point exactly at the center of the front axle to each of the two rear brake-drums. The distance should be exactly the same on both sides.

Although the adjustment for toe-in is usually made from the tie-rod, it must be borne in mind that if a spindle-arm is badly bent it cannot be corrected by shortening or lengthening the tie-rod. This is because each spindle-arm should be set so that it will point directly toward the center of the rear axle, to give the correct degree of angularity to each front wheel when the car is turning a corner. The wheel that is on the inside of the curve is cutting a smaller circle; therefore, it must be turned at a sharper angle. This is accomplished by having the steering-arms point directly toward the center of the rear axle.

Trueness of Wheels

It goes without saying that each front wheel, as well as the rear, should revolve true on its axis. The best method for testing this is to jack each wheel up and turn it. If the wheel is not running true, it can be detected readily in this way. Wheels that do not run true in this way are called wabbly wheels; but, although they do other bad things, they do not affect the tire wear. A wheel will always roll in the direction that is exactly at right angles with its axis, regardless of whether it runs true on its axis or not. If the wheel is not running true on its axis it will leave a crooked track, but the wheel will not tend to crowd to either one side or the other.

The principal disadvantage of wabbly wheels is that the wheel constantly tends to right itself, due to the centrifugal force, and this tendency increases with the speed of the car. By actual test, a wheel that was turning at a speed of 500 r.p.m. and was 1 in. out of true, was so affected by this centrifugal force that it ran almost in a perfectly true circle but, in doing so, it caused the hub to wabble although the hub ran perfectly true when the wheel was being turned at lower speeds. This condition has a tendency to "crystallize" the spindles and the steering-arms, especially on a car that is likely to be driven at a high rate of speed. A wheel running ⅛ in. out of true in this way would do no serious harm, but I would object seriously to driving a car at a high rate of speed if a wheel were more than ⅛ in. out-of-true in this way.

Comparison with Other Methods

Regarding how much toe-in this 3/16 in. taken 9 in. from the floor would amount to if taken on a level with the center of the wheel, a 30 x 3½-in. wheel tested from the tires and given 3/16-in. toe-in at 9 in. from the floor

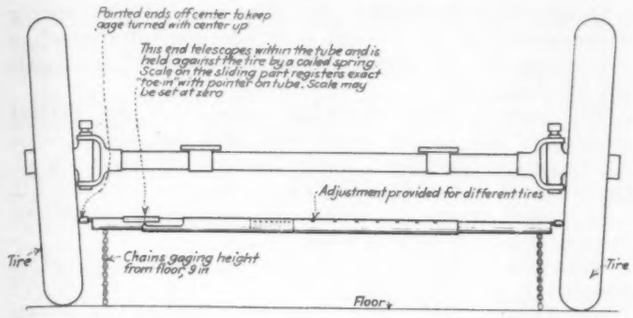

FIG. 3—GAGE FOR TESTING THE AMOUNT OF TOE-IN

This Gage Is Adjustable for Different Sizes of Tire and the Chains Indicate Whether or Not the Gage Is Set at the Proper Height from the Floor, 9 In.

would be exactly 3/16 in. if taken from the center where the tire and rim meet. It would be 1/64 in. less if taken level with the center on the felloes, and 1/64 in. more if taken level with the center on the tires. A 33 x 4½-in. wheel given 3/16-in. toe-in when tested from the tires at 9 in. from the floor would have exactly 3/16-in. toe-in if taken level with the center on the rim, but would be 1/64 in. less if taken from the felloes, and would be 1/32 in. more if taken from the tires. A 36 x 4½-in. wheel given 3/16-in. toe-in, when tested from the tire at 9 in. from the floor, would be exactly 3/16 in. if taken level with the center on the felloes and would be approximately ¼ in. if taken from the tires.

FRONT-AXLE TILT

The tilting of the front axle, it is generally agreed, is done to give the wheels a "caster" effect; that is, to bring the wheel in contact with the road at a point back of a line drawn through the center of the king-pins. This is done for three purposes. First, to avoid any possibility of the king-pin becoming pitched in the opposite way, which would cause serious results. Second, to cause each wheel to follow the king-pin in case the tie-rod should break or become disconnected. Third, if the king-pins were not pitched in this way, when driving through sand or mud that part of the wheel pushing against the sand or the mud would be so far in front of the king-pin that the wheels would tend to turn sidewise. The amount of tilt given to the front axle varies slightly with different types of construction, but between 2 and 3 deg. will give excellent results on all cars.

AXLE-TILT AND WHEEL-ALIGNMENT

While the tilting of the front axle does not come directly under the heading of wheel-alignment, it affects wheel-alignment to the following extent. The wheels are closer together at the bottom on practically all cars; on some cars as much as a 3-in. difference exists, while the toe-in is only 3/16 in. Any condition that would allow the angle of the front axle to change might very easily change part of that 3 in. of camber to toe-in, thus affecting the amount of toe-in seriously. In some types of construction the angle at which the axle is tilted is different when the car is loaded from what it is when the car is empty. On this type of construction it is very important to test the wheel alignment after the body has been placed on the chassis, as the weight of the body is enough to affect the amount of toe-in.

The amount that the front axles are tilted varies. Insufficient tilt will cause the wheels, when turned in either direction, to pull hard in that direction. For instance, in turning a corner, difficulty is experienced in bringing the wheels back to a straight-ahead position if the tilt is insufficient. The correct amount of tilt will have a tendency to bring the wheels back to a straight-ahead position after turning a corner, but too much tilt will cause a noticeable tendency for the wheels to turn toward the side of the road when being driven on either side of the crowned road.

WHEEL-WABBLE

Another condition that is caused by too much of the caster effect is a tendency, when driving at certain speeds, for the wheels to change their course rapidly from right to left and to continue to alternate until stopped either by changing the speed of the car or by a change in road conditions. This tendency is increased greatly if the connections between the steering-gear and the wheels are of a springy construction. On some cars, a spring is located at each side of the ball-joint on one end of the tie-rod. This condition, even with the correct amount of caster effect, will sometimes cause the wheels to alternate from side to side in the manner just stated. This condition very often can be corrected by removing one of the springs mentioned and placing a solid block in its place. It can be improved still further by having one spring at each end of the drag-link, one allowing the distance between the two ball-joints to lengthen and the other allowing it to shorten if the necessity arises, but each one always coming back against a solid stop.

On some cars the drag-link and the front spring are hung in such a way that, when the spring is depressed, the wheels must turn to one side, the steering-wheel must turn in the hands of the operator or something must bend. When a car is being driven on a wavy road, this makes the steering very uncertain as the wheels will turn from one side to the other, not rapidly as in the case in which the caster effect is too great, but with each toss of the car. Another bad effect resulting from this condition is that, if the steering-gear is irreversible and the wheels fairly heavy, the steering-gear and the drag-link bearings loosen rapidly. This very often can be remedied by bending the arm at the front end of the drag-link up or down, so that the front ball-joint will be in a direct line with the rear ball-joint and the front spring-bolt, as in Fig. 4.

SUMMARY

A car with the wheels in proper alignment should have the rear axle at right angles with the frame and the rear wheels parallel with each other. The front wheels should be the same distance apart at the bottom as the rear wheels, but farther apart at the top than the rear wheels are. The front wheels also should be toed-in 3/16 in. after having been sprung outward and allowed to come back as far as the friction of the tires will allow. The front axle should be tilted so that the king-pins will be farther forward at the bottom than they are at the top. The spindle-arms should point toward the center of the rear axle, and the front and the rear joints on the drag-

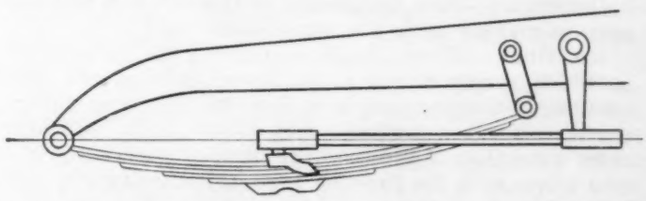

FIG. 4—HAVING THE FRONT AND REAR BALL-JOINTS AND THE FRONT SPRING-BOLT IN A STRAIGHT LINE AS SHOWN WILL CURE WHEEL WABBLE

link should be in a direct line with the front spring-bolt.

The best method of testing for toe-in is to take the reading from wheel to wheel, on the tires, 9 in. from the floor, at the front; then to move the car forward and take the reading from the identical spot on the tires, 9 in. from the floor, at the back. The importance of taking the reading from the same spot on the tires cannot be overestimated. The rear wheels are tested in the same way, except that the car is moved backward.

The method of testing for camber is to suspend a plumb-line over the outside of the tire 4 in. in front of the hub. The method of testing the rear axle to see if it is square with the frame is to measure from the center of the front axle back to each rear brake-drum. The distance should be the same on each side.

All these features are essential to good steering and to the safe and economical operation of an automobile. Every shop should be equipped with adequate means of testing for each of these different conditions. I sincerely hope that testing for wheel-alignment with a string or a stick has practically been discontinued.

THE DISCUSSION

QUESTION:—To what extent is wheel-alignment affected by smooth roads and by heavy or rough roads?

JOHN F. DUBY:—Heavy mud or sand would require more toe-in than a smooth road, if driving through it all the time, but we must come as near as possible to meeting all conditions. I use a 1/16-in. tolerance in either direction from the 3/16 toe-in. Differences in the road conditions would rarely make more than a ⅛-in. difference in toe-in; so, even on heavy roads, the toe-in probably would not be more than when running straight on smooth roads. In mud or sand it makes only a slight difference if the wheels toe-out some, because they have a chance to give without slipping or wearing the tires. We should consider the conditions under which we do most of our driving and have the wheels adapted to both hard and soft roads; if adapted to one kind of road only, they will slip and grind the tires on another kind of road.

QUESTION:—It is noticeable that one wheel seems to be the one that wears the tire, when both wheels are out-of-line. What does this indicate as to toe-in?

MR. DUBY:—If the wheels toe-out, almost always the left-hand front-tire wears; if they toe-in, the right front-tire will wear because most of our driving is done on crowned roads; the right tire pushes toward the center and the left tire toward the side. The left tire has the advantage. This is more noticeable in a light car in which a man drives mostly alone. There the weight on the left side of the car is more and that holds the left front-wheel down; so, it takes the course in which it is pointed, and the right-hand tire takes the slip. This condition was not so noticeable with the right-hand-drive cars. The difference in the weight on the right side equalled the disadvantage at which the right-hand wheel was in pointing toward the center of the road and equalized the amount of slip on the wheels.

QUESTION:—Does the amount of tire-inflation play any part in making tests for wheel-alignment?

MR. DUBY:—Tires should be pumped to the pressure at which a man drives a car before making the tests because, if the pressure is so low that the tires flatten, the wheels, when pushed apart at the front, will stay apart more than if the tires are pumped hard. But if a man drives with the tires not hard, the spindles will tend to bend backward; so, if one drives with a low tire-pressure, the wheels should be tested when they have low pressure to give the best results.

QUESTION:—Regarding the changing of the spring arrangement in the tie-rod with the idea of correcting shimmying of the wheels, should the angle of front-axle tilt be changed?

MR. DUBY:—This condition, even with the correct amount of tilt to the front axle, will sometimes cause shimmying. Therefore, I say that one is as much responsible as the other although, if the axle does not tilt, it is almost impossible to get the shimmying conditions to continue on a smooth road.

QUESTION:—When the wheels are pushed apart before measuring, does the degree to which they return vary?

MR. DUBY:—No. If a weak man pushes the wheels apart, they come back nearly to their normal position after he lets go. If a strong man pushes them apart, they will still return nearly to the position they started from. If one were to hold the wheels while making the test, it would make a difference; letting go, they will always come back nearly to the original position.

QUESTION:—What effect has the friction due to the character of floor surface on the final position of the wheels after being pushed apart? What is the difference between a greasy floor and a cement or wood floor free from grease?

MR. DUBY:—A greasy floor causes a difference, but a wood or a concrete floor makes practically no difference.

QUESTION:—When the drag-link is located close to the wheel, does that make much difference?

MR. DUBY:—When the drag-link runs crossways of the car, the lower end of the arm that extends from the steering-gear should be nearly in line between the two ends of the tie-rod or, at least, so that the drag-link will run almost level from the steering-gear to the spindle-arm. Otherwise, if the steering-gear were on the left side and the drag-link at the right and if the end connected to the steering-gear were higher, the drag-link would tend to push out in going down and turn the car to the left. The drag-link should be kept fairly level.

QUESTION:—Does center-point steering make a difference in the amount of camber required?

MR. DUBY:—The tilting of the king-pin outward, away from the center, will not affect the amount of camber; neither will it affect the tendency for the spindle to bend upward; because, although the center of the king-pin points toward that part of the tire that comes in contact with the road, if a plumb were dropped from the center, it would strike the road at a point inward from the center of the tire on the road. The necessity for camber would still exist and also of toe-in. Their requirements would be practically the same. The tendency for the spindle-arms to bend backward would be decreased in that construction, but the necessity for toe-in and camber is the same.

QUESTION:—How do front-wheel brakes affect wheel-alignment?

MR. DUBY:—So far as I have examined them, on all the cars, I believe, that are now in Boston and on at least one foreign car, front-wheel brakes will not affect wheel-alignment in any way except that they make it necessary to use stiffer spindle-arms than we use at present. Front-wheel brakes do not affect wheel-alignment because, on all cars of which I know, the king-pin is pointed outward at the bottom, thus bringing its center in line with the point at which the tire strikes the road. When using front-wheel brakes, the king-pin must be set out so that it will be in line with the center of the tire where it comes into contact with the road.

QUESTION:—I have had the right-hand front-tires wear concave on the outside during the past year; the center

remained in perfect condition. What is the reason for this?

MR. DUBY:—If the tires wear on the outside of the right front-wheel, that is almost a sure sign that the wheels are not perfectly lined-up. Some would say that the wheels are perfectly adjusted if 3/8-in. toe-in is allowed, the reading being taken from the felloes at the center, but any car equipped with stiff arms will not stand 3/8-in. toe-in if the readings are taken from the felloes. That will cause tire wear, and it cannot be remedied until the amount of toe-in is decreased.

QUESTION:—What about the cupping of tires? Tires wear in waves.

MR. DUBY:—The general practice of cambering, or setting the wheels closer together at the bottom, is thought by many not to affect tire wear, but after 2 deg. of camber, the "cupping" conditions mentioned are produced because the wheel strikes the road before it has completed its inward travel as it goes toward the bottom. It must either slip or distort the tire as it approaches the bottom. It slips until the pressure on the tire is sufficient to hold it from slipping; then, as it slips, it has to slip back as the tire leaves the road. Therefore, a double slip takes place, unless one is driving on a crowned road so that the wheels make contact with it at right angles; then, the wheels crowd from the center, and some tire scuffing results. A tire with a long crossbar would take a good grip on the road as the tire rolls from the point of contact to the point at which it leaves the road; a short crossbar would take the slippage. On tires having uniform knobs or buttons, one end of each knob will wear, leaving the other end practically not worn at all. This is due to the camber effect. As the car is driven, the slippage all comes from the time the tire comes into contact with the road until it reaches the bottom. If a car is being driven at a high rate of speed, most of the time the tire, as it leaves the bottom and approaches the point of leaving the road, does not touch the road at all in some cases. I have been told, by engineers present when tests were made, of a picture of a tire that did not touch the road from a point a short distance back of the center; and to where it touched the road in front of the center was four times as great a distance because it takes time for a tire to resume its shape after it has been depressed. At a high rate of speed, that part of the tire has been carried away from where it would come into contact with the road.

R. E. NORTHWAY:—I had a car 5 years ago that showed bad tire wear on the right side. I had a replacement and tested the wheels. Finally, I had the springs taken off and found that, from the center of the front eye to the center-bolt the right-hand spring was 1/4 in. short and the left-hand spring 1/8 in. long, a difference of 3/8 in. I remedied this by getting two springs that matched. Tire wear ceased at once. Little things enter into the proposition of wheel-alignment. Differences of camber and of springs make a difference in both tire wear and wheel-alignment.

MR. DUBY:—Perhaps the trouble Mr. Northway mentions was corrected in some other way, while the work on the springs was being done. I see no reason why having one end 1/4 in. farther back than the other would cause any tire wear. If the front axle is farther back on one side than on the other, both of the wheels point ahead and will roll perfectly freely until such time as they have to go round a corner or in a circle. Then they will be out-of-line because the two spindle-arms do not point directly toward the differential. If the rear axle were from 2 to 3 in. out-of-line, that condition would be serious enough to cause tire wear, but I do not see how 1/4 in. could make any difference. I have seen the wheel-alignment changed 1/4 in. by putting a new radius-rod on the front end of a car, because, in putting the rod in, the tilt of the front axle was changed. In the case Mr. Northway cites, putting in a new spring may have changed the tilt. If we turn the front axle one-quarter turn, the wheels toe-in the full amount that they were originally cambered. On one car that I saw in Detroit, they tested the wheel-alignment before putting on the body and allowed 1/4-in. toe-in, and the tire wear after the car left the factory was considerable. I tested one of the cars with the body on and found it to be toeing-in 3/8 in. A sedan car toed-in 7/16 in. We tested 10 or more out of a row of cars, and found they averaged more than 1/4-in. toe-in on each one. I took a pointer, for testing, placed it between the wheels and jumped the body up and down, the pointer moved in and out almost 1/4 in. It was decided that it was best to test wheels after the bodies were installed, instead of before. The tilt was changed after the weight was added to the car. One make of car, having an original toe-in of 1/4 in., will be toeing-in 5/16 in. with five people in the car; however, a difference of 1/16 in. will cause no serious harm.

QUESTION:—Is there any direct proportion between camber, tilt and toe-in?

MR. DUBY:—As stated in my paper, by increasing the amount of camber, the wheels are brought into contact with the road at a point nearer to being under the center of the king-pin, thereby eliminating one reason for toe-in; but, by cambering, we make a cone of the wheel at the point where it comes into contact with the road, thus adding a different reason for the toe-in and one offsets the other. The amount of toe-in will be the same, regardless of the camber. I have tried this out thoroughly and am well satisfied on that point. The wheel alignment is not affected by the tilt, so far as measuring when cars are standing still is concerned. If the degree of tilt is changed, that changes the amount of toe-in. In other words, the degree of tilt does affect the wheel-alignment by causing shimmying. That is not a difficult defect to discover in measuring wheels when standing still, but it affects the driving and the steering. The amount that wheels are cambered will not affect the amount they should be tilted. The amount the axle is tilted, if kept within reasonable bounds, will not affect the amount that the wheels should toe-in.

QUESTION:—Considering a left-hand-drive car, what is the proportion of cars that show the most wear on the right-hand front tire?

MR. DUBY:—Neither the wheel nor the tire knows which steering-arm that steering-gear is connected to. The tie-rod is holding one arm just as rigidly as it does the other, unless the tie-rod should be very springy and bowed down in the center. On that type more toe-in will be required, due to the fact that, as the car goes along, the tie-rod will bow down more as the car goes faster; so, we must give that car more toe-in, but it is done automatically. The tie-rod springs down and comes back; therefore, if the testing is done right, no difference as to tire wear will be noticed.

MR. NORTHWAY:—Mr. Duby suggested that we provide a caster effect of 3 deg. We made some tests on that in bus work up to 4 deg.; this increased the ease of steering, but certainly increased the shimmying effect. We found that 2 deg. was the maximum we could allow safely. A caster effect of 3 deg. was too much for high-speed work and rough roads. The wheels would wabble and we could not control it.

MR. DUBY:—The condition may have been due to this very thing that I mentioned about two springs in one end of the drag-link. This gives a steering-gear that does not necessarily come back to the same spot, but if we put one spring in each end, with one allowing the drag-link to lengthen and the other permitting it to shorten, the steering-gear comes back to a stop, and we will have the link so it will always come back to the same point and correct the tendency to rock. Possibly, on a 37-in. tire, 3 deg. of camber would be too much. I have not tested with so large a tire. Most of my testing has been on smaller tires.

MR. NORTHWAY:—All our tests were made with drag-links that were equipped with one spring in each end, one allowing the link to lengthen and the other allowing it to shorten.

THE PRICE OF AGRICULTURAL PRODUCTS

THE average agricultural output in the first decade of this century was only 11 per cent more than in 1899; while in manufactures it amounted to 34 per cent. In 1909, the index of agricultural production stood at 118 and manufactures at 163. The population of the country in this same period had grown more than 20 per cent. Nearly all of this addition to our people was found in cities and towns. Of the 15,000,000 people who had been added to our numbers, more than 12,000,000 became city dwellers. For the 20 years from 1899 to 1919, the volume of farm products had increased by 35 per cent, while the output of manufactures had grown by more than 100 per cent. Our population in the same time had become 40 per cent larger, while the dwellers in cities and towns had increased by 60 per cent.

From 1899 to 1909, freight rates were practically stationary; they did not join in the upward movement of prices. In fact, this situation continued until the end of the year 1917. Not until 1920 were freight rates raised to the level of other prices. The revenue per ton of freight moved 1 mile had been 1.232 cents in 1880. From that level it fell to 0.729 cents in 1900 and remained practically stationary until 1917, when it stood at 0.717 cents. In March, 1921, it stood at 1.33 and in 1923 it is 1.10 cents per ton-mile. The effect of this failure to adjust freight rates to the general movement no doubt had much to do with the rapid increase in farm prices and in land values.

In 1900 came the Boer War and in 1904 the Russo-Japanese War. Both these conflicts had the effect of stimulating the demand for American farm products. The nations involved in these wars were able to command credit with which to buy the things they needed. The three decades of peace and of industrial development that had preceded had placed the world in a position where Government bonds were readily absorbed by the international money market. In addition to these military conflicts, Europe, like ourselves, was enjoying an unprecedented industrial development. Mining, manufacturing and construction work were active and were yielding large profits. Population was increasing. The growth of cities is not alone an American manifestation during the first two decades of this century; it was universal in the Western world. All of this accentuated the tendency of demand for agricultural products to outrun the supply at the old prices.

For many years people have moved from the farms to the cities; and for many years, too, people who came into this country as immigrants have settled in our industrial centers rather than on our farms. By this process the number of people in cities and towns grew from about 45,000,000 in 1899 to almost 75,000,000 in 1919; while the number of people on farms remained almost stationary at not far from 30,000,000. The former had to be fed by the latter. As a result of this disparity in the growth of population and the consequent disparity in the volume of agricultural production as compared with industrial output, the prices of agricultural products rose more rapidly than did those of other things. Unless all precedent fails, the renewed movement of people from the farms to the cities, which has been in progress since the revival of business from the recent depression, will do more to restore the balance that the farmer seeks than any legislative action can possibly accomplish.—Prof. David Friday, New School for Social Research.

CENSUS OF VEHICLE INDUSTRY

THE reports made to the Bureau of Census by the manuturing establishments in the United States show that the value of their products aggregated $43,653,283,000 in 1921, as compared with $62,041,795,000 in 1919, a decrease of 30 per cent. Compared with the value of products reported for 1914, this represents an increase of 80 per cent and was due largely to the rise in prices. The average number of wage-earners employed in 1921 was 6,946,564, or 23 per cent less than the number reported for 1919. The difference between the figures shown for 1914 and 1921 is very little. The census statistics for 1921 relate only to establishments having products valued at $5,000 or more, whereas at prior censuses the corresponding limit was $500.

The accompanying table summarizes the statistics for 1921, for vehicles for land transportation. It will be noted in this connection that while the carriage and wagon factories, including repair shops, are more than double the plants building motor vehicles, the latter employ a much larger force.

STATISTICS OF VEHICLES FOR LAND TRANSPORTATION FOR 1921

Industry	Number of of Establishments	Average Number of Wage Earners	Value of Products
Motor Vehicles	385	143,658	$1,671,386,976
Motor-Vehicle Bodies and Parts	1,947	69,119	408,016,532
Carriages and Wagons, Including Repairs	826	7,797	31,658,791
Carriage and Wagon Materials	141	2,747	10,787,177
Carriages and Sleds, Children's	89	5,460	21,716,839
Cars, Electric-Railway, not Including Operations of Railway Companies	10	2,912	14,856,068
Cars, Steam-Railroad, not Including Operations of Railroad Companies	108	45,121	325,680,157
Motorcycles and Parts	22	2,665	13,567,970
Bicycles and Parts	24	1,643	9,529,779
Wheelbarrows	11	228	1,454,581
Total	3,590	281,350	$2,508,654,870

The Public's and the Car-Builders' Attitude Toward Balloon Tires

By J. E. HALE[1]

INDIANA SECTION PAPER *Illustrated with* PHOTOGRAPH AND DRAWING

STATING that the adjustment records of the tire companies afford ample proof that under-inflation is one of the most flagrant forms of tire abuse, the author cites this to show that the public demand is to ride on tires having low inflation-pressure on account of the comfort secured thereby. Statistics obtained in 1922 show that endurance, economy of operation and comfort head the list of car attributes that the public desires most. It is claimed that these qualities are securable by using low-pressure air in tires or sufficiently large cross-section and special design.

An analysis of the opposition to balloon tires, the effect of balloon tires on acceleration and pick-up, an argument to show that the balloon tire is a distinct type, details of balloon-tire application to cars and rebound-checks as adjuncts to the use of balloon tires comprise the main divisions of the paper. Six specific conclusions are presented.

IN the paper entitled Shoeing a Car with Low-Pressure Air,[2] which I presented at the Semi-Annual Meeting of the Society, at Spring Lake, N. J., in June, 1923, the treatment of this subject was from a tire-maker's point of view. I reported my observations on what the tires would do for the car and how they would affect the operation of the car, made some predictions on their durability and cost and concluded by proposing a line-up of sizes with a recommendation for amounts of air pressure. This summarized the very extensive development work in which we had been engaged and was really a first presentation of the subject to the industry. Since then the matter has been given such wide publicity that not only the car-builders but a considerable proportion of the public have become acquainted with the possibility of riding on low-pressure air. All the car-builders have had sample sets of balloon tires for experimental purposes. Also, many private owners have had their cars changed-over and have been running on this new form of tire equipment for many months. It seems desirable at this time to review the reactions of these two groups and to see what conclusions can be drawn.

The primary motive underlying this movement was the belief that the motoring public would appreciate a type of tire that would permit it to use low-pressure air, in order that it might enjoy the greater personal comfort of much improved cushioning, the protection that soft tires give to the mechanism of the car and the improved traction that would result from greater tread contact. As a matter of fact, this demand for low-pressure tires has actually existed for a long time. The proof of this is that many people under-inflate their tires. The tire companies have ample evidence of this; their adjustment records show under-inflation to be of the most flagrant forms of tire abuse and, while undoubtedly many of the cases are due to negligence, it is well known that it is common practice for car-owners, who do not figure tire-mileage costs, to run deliberately at low inflation for the comfort and protection that they can secure.

Since disclosing the balloon tire and explaining that it is deliberately designed to use low-pressure air, the public has grasped the idea, and definite indications are noticed that it will take matters into its own hands and ride on low-pressure with its present equipment which, of course, is something we cannot authorize with the heavy, thick-wall construction. The important point is that the public wants the personal comfort, the protection of the car and the like that low pressure gives. Our problem is to produce the true low-pressure tire that we can stand back of.

Further evidence of the logic of this movement is given by the returns of the ballot taken by the National Automobile Chamber of Commerce in 1922, in which it sought "what the public wants" from 20,000 car-owners. In these returns, endurance, economy of operation and comfort head the list of the attributes the public desires most, and these are the things that we claim are had by the use of low-pressure air. The returns were reported as shown in Table 1.

TABLE 1—CAR ATTRIBUTES DESIRED MOST

	Per Cent
Endurance	15.0
Economy of Operation	14.0
Comfort	9.5
Price	9.5
Appearance	8.0
Service, Good Local Repair Shops	7.5
Hill-Climbing	7.0
Flexibility	6.5
Endorsements, Opinions of Other Owners	6.5
Specifications	6.0
Speed	5.5
Appointments	5.0
Total	100.0

One of the big problems that has always confronted the tire manufacturers is convincing the motoring public that it must inflate its tires properly to avoid premature failure due to under-inflation. The fight to maintain air pressures is so old, and has been carried on so persistently, that the motoring public has accepted proper inflation as one of the nuisances that are necessary to the use of the automobile and, in a general way, it understands some of the reasons. But few have raised the question as to designing tires that could be run at a much lower inflation-pressure. The solution of this problem was not evident to tire designers until the evolution in the tire industry had opened the way for the balloon tire. Now it seems so simple and logical that we naturally wonder why we did not think of it before. With the details worked out, the public grasped the idea instinctively and the reaction we get from individuals is indicated by the questions they ask, such

[1] M.S.A.E.—Manager of the development department, Firestone Tire & Rubber Co., Akron, Ohio.

[2] See THE JOURNAL, July, 1923, p. 41.

as: "How does it affect the steering?" "Does it cut down the gasoline consumption?" "How much do they cost?" "What air pressure is used?" "Can I buy a set for my car?"

Realizing that a sizable portion of the public had discovered the attractive features of riding on low-pressure air, we felt well pleased with our efforts when we discovered the way to make riding on low pressure legitimate. The psychological reactions that we have encountered among the motor-car builders, however, have disclosed various points of view. Of course, the first reaction in most cases was that of curiosity, to learn as much as possible about the tires from personal observations on sample sets. Then, true to the responsibilities of their positions, each and every car-designer proceeded to search for objections to this new equipment; naturally, they found that the balloon tires, having some characteristics different from those of high-pressure pneumatics, could not be substituted without due consideration. They agree almost universally that the low-pressure tires give a better ride; in no case have I heard any contention that the tires do not do what we claim for them, yet the attitude toward them ranges all the way from actual adoption to direct opposition, with all kinds of intermediate opinions. So, the matter we are facing in satisfying the public on low air-pressures is to examine more closely into the apparent resistance toward the adoption of this type of tire. In a general way, it must be due to psychological, engineering or economic reasons.

Analysis of Balloon-Tire Opposition

So far as economic reasons are concerned, the monetary appropriations involved are not excessive, since they are confined to fender charges and details of brake and axle design to provide additional offset. As to engineering obstacles, I have not heard of anything insurmountable in this direction. Naturally, a new tire-equipment of this description could not be expected to fit the vehicles without some alterations or modifications; but I submit as proof that the objections cannot be serious the fact that, of the dozens of cars which have been changed-over, the owners have found them to be entirely satisfactory. Of course, in some cases the fenders were not wide enough with the new equipment and as a result mud would be spattered in an objectionable manner; but this is simply something for the car engineers to overcome by redesigning the fenders.

In a few cases, car designers have encountered front-wheel shimmy with cars fitted with balloon tires and for that reason have disapproved of this form of equipment. So far as I have been able to discover, this form of trouble almost never occurs at speeds below 60 m.p.h. A few cases of front-wheel shimmy have come to my attention on change-over jobs but in all cases the shop mechanics have been able to make some adjustments in the steering mechanism that eliminated it. On my own roadster car I can bring about front-wheel shimmy at any time by slacking-off a three-quarter turn on a certain nut in the steering linkage, thereby introducing a certain amount of play, but I can remove it simply by tightening this nut again.

The effort required for steering receives very prominent consideration, of course. A soft tire steers somewhat harder than a highly inflated tire, and this low-air-pressure project caused many people to make comparisons. Some steering-gear changes have already been made, and gears are available which give satisfactory results. We feel sure that this objection will disappear.

Effect on Acceleration

Another point that has come up in a few cases, and apparently has been registered as a primary objection, is that the acceleration in car performance is affected adversely by low-pressure tires. One can understand readily why the car-builder who has expended a large amount of time and effort in trying to excel in acceleration is reluctant to have any elements introduced in his equipment that will disturb the performance of the car, in this respect; but, so far as I have been able to determine, the low-pressure tires affect the engine performance only slightly. On a coasting test, as one senses the action of a car rolling downhill in ordinary driving, certainly no evidence of drag or sluggishness is present.

So far as fuel consumption is concerned, plenty of information is available to the effect that this is not affected adversely; in fact, evidence can be adduced that there is a slight increase in gasoline mileage when using the balloon tires. I have just completed a 1200-mile trip in my 4-year-old roadster that was equipped with balloon tires and pretty heavily loaded. I averaged 17 miles per gal. for the entire trip.

Predictions of serious accidents have been registered in case one of these thin-wall tires should blow-out on a vehicle running at high speed, particularly a front-wheel tire. So far, no trouble has been experienced from this source; surely, if the allegation were true, something would have happened long before this because a large number of these tires have been in service long enough to give actual experience along this line. The experiences that have relieved most completely the minds of those who were apprehensive in this regard are those of Cannonball Baker. He had a front tire go flat while running a touring car, 55 m.p.h. He reported that he noticed no particular difference in the performance of the car with the 7.30-in. balloon-tires, which he had on the car at the time, and similar occurrences that he had previously with the regular 33 x 5-in. high-pressure tires. In other words, there was nothing dangerous, the only reaction being a slight tendency for the car to draw to the flat-tire side. He had a tire go flat on a rear wheel while running 75 m.p.h. Inasmuch as he was attempting to make a record, he continued to run at high speed for 15 miles on the flat tire. Fig. 1, shows the condition of this tire after it was sent in for our inspection. The punishment was so severe that the rubber was actually all gummy from being devulcanized. But the important thing is that he was able to drive the car with this dish-rag-like appendage on the wheel. Incidentally, it is interesting to note the thorough-going way in which the company that built the touring car mentioned was able to investigate air-cushion tires by putting the car, so equipped, into the hands of a driver like Cannonball Baker. This course enabled the company to reach conclusions very quickly.

At the inception of this balloon-tire idea, we were rather of the opinion that we were developing a luxury tire which probably would be limited to application on cars of the more expensive type; but, as our work expanded and we began to get reactions from car-builders, it became apparent that the low-pressure air would be universally desirable. As a matter of fact, low-pressure air in tires offers a greater improvement comparatively in comfort and in protection to the vehicle in the case of moderate and low-priced cars.

Balloon Tires A Distinct Type

It should be understood definitely that what we term balloon tires, while they resemble the high-pressure

pneumatic tires, are sufficiently different in many of their details to constitute an entirely distinct type. The distinguishing features of a true balloon-tire are: a very thin carcass, narrow rim-fitting, air-pressure recommendations for actual use ranging from 20 to 35 lb. per sq. in., a small-diameter rim to accommodate standing diameters no greater than those used at present and special tread designs adapted to low-pressure tires. My opinion is that the present line of tires and rims cannot be converted into the true balloon-type by oversizing and splitting the difference in the number of plies used. A satisfactory series of tire sizes for the new type has been under development for practically a year and in the following text I report certain general observations on the application of it to motor cars. This is a problem having two aspects; that is, the application of balloon tires as original equipment and their use as a change-over equipment for cars now in service. Our judgment is that four section-sizes of tire are necessary to equip the various cars properly with tires and at the same time to allow the pressure recommendations of from 20 to 35 lb. per sq. in. In a general way, the choice of tire sizes to be applied to the various cars is shown in Table 2. We have found that the cars can be grouped according to their wheelbases much more logically than in any other way, because cars of approximately the same wheelbase are likely to be of about the same weight. Some wheelbases are omitted from Table 2. These are border-line cases for which the tire sizes must be chosen by careful consideration of the front and rear weights when the car is loaded.

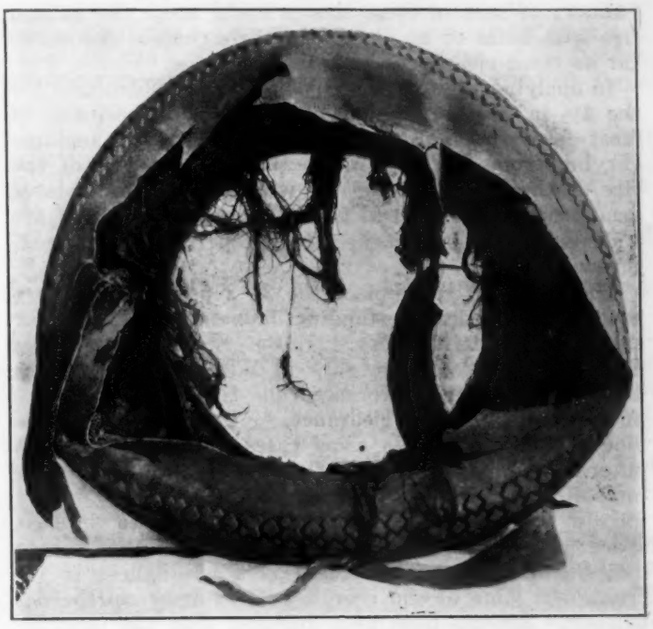

FIG. 1—A BALLOON TIRE THAT RAN FOR 15 MILES AT HIGH SPEED AFTER GOING FLAT AT A SPEED OF 75 M.P.H.

TABLE 2—BALLOON-TIRE SIZES SUITABLE FOR THE VARIOUS CARS

Balloon Tire, Actual Section, In.	High-Pressure Pneumatic-Tire Equivalent, In.	Maximum Load per Wheel, Lb.	Wheelbase Range of Cars for Each Size of Tire, In.
4.40	3.5	750	100 to 103
5.25	4.0	1,000	108 to 115
6.20	4.5	1,300	118 to 126
7.30	5.0	1,700	130 to 140

BALLOON-TIRE APPLICATION

When the factory fits balloon tires to new vehicles or does change-over work on existing cars, only two problems arise; first, how much to offset the rear wheels to clear the brake rigging so that the sidewall of the tire and the flange of the rim will clear; second, how to provide means for carrying the spare tire. Fig. 2 enables one to visualize the relative positions of the two types of equipment. In cases where the rear wheels do not have to be offset and the brake-drums are not too large in diameter, the wood wheels can be rebuilt using a steel-felloe wheel and a demountable rim that has been designed especially for these tires. These demountable rims are of the endless type and have a spring side-ring. Where wood wheels cannot be used because they cannot be offset sufficiently, either wire or disc wheels must be resorted to and for these cases the same type of rim has been worked out in such a manner as to be built into the disc or the wire wheel as the case may be.

We have found that fitting tires of the 4.40 and 5.25-in. size to cars in their respective classes, is a fairly straightforward proposition, the fender and the brake-drum clearances being naturally sufficient to accommodate the tire change without any complications. The

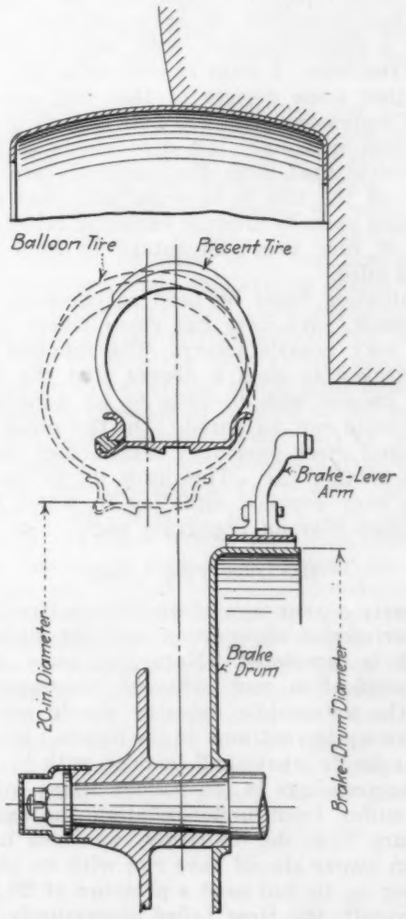

FIG. 2—RELATIVE POSITIONS OF BALLOON AND PNEUMATIC TIRES AS APPLIED TO AN ORDINARY WHEEL

builders of cars in these classes could adopt the balloon tire with little or no change in their chassis design, so far as these clearances are concerned.

In applying the 6.20-in. balloon-tire as a substitute for the 4½-in. size on cars of 118 to 126-in. wheelbase, in most cases the rear wheels must be offset by amounts varying from ½ to ¾ in. so that the sidewall of the tire or the flange of the rim will clear the brake-lever arm properly. In practically all cases the fenders are wide enough to cover the tires properly against mud-throwing.

The 7.30-in. tires replace the 33 x 5-in. size and are practically identical in standing diameter; so, the fender clearance is satisfactory. However, the brake-drum diameter of these large cars is sufficiently great that brake-mechanism interference calls for a greater offset of the tire for proper clearance, ¾ in. or more; so, the sidewall of the tire in some cases is rather near the outer fender-line and this, of course, would account for mud-slinging. Car-builders naturally are reluctant to narrow the wheel housing because it cuts into the seat space; as a result, the resistance on this point is rather difficult to handle unless there is a willingness to increase the gage of the rear wheels to make up the deficiency. Reports have been received that the turning-radius of the steering-wheels has been reduced slightly with this size in some cases.

Rebound Checks

In my former paper[a] I mentioned the desirability of using shock-absorbers or spring-rebound checks and predicted a disappointment with balloon tires without these instruments. I want to emphasize now even more strongly that some devices of this sort are necessary. The low-air-pressure tires will take care of the pavement irregularities splendidly but depressions in and humps on the general road level, that naturally are beyond the capability of the tire to care for and that call on the spring action seem to produce excessive rebound. I have found it of very great advantage to keep the spring leaves well oiled.

Discrimination must be used in choosing a type of rebound check. We have had cases where the applications are very unsatisfactory. The rebound seemed to be over-checked to such a degree that the riding was extremely choppy and, in spite of all adjustments, the condition could not be cured. On the other hand, the same rebound check gave very satisfactory results when applied to another car. This leads me to conclude that there is a very complex situation in which the spring characteristics play an important part.

Balloon-Tire Usage

It is nearly a year now since balloon tires have been under experimental observation and the major development work is completed. Naturally, some details will require modification and different treatment, but we feel that the automobile industry should consider this form of tire equipment now in its hands. It is for that industry to decide what shall be done with it. We know of some shortcomings in the balloon tires; for instance, they will suffer from under-inflation the same as the high-pressure tires do. Already, we have had a case in which an owner should have run with an air-pressure of 30 lb. per sq. in. but used a pressure of 20 lb. per sq. in. As a result, the tires failed prematurely. We find that in many cases individuals think that it will be possible to use pressures much lower than those we really contemplate.

Front-wheel alignment must receive more attention on cars equipped with the balloon tires. Premature tread-wear because of misalignment is common; the low-pressure tires are much more sensitive to this form of abuse than are the high-pressure tires. Our whole experience leads to the following conclusions:

(1) Unquestionably, the public will ride on low-pressure air
(2) The tire companies must meet the situation by designing and marketing tires that can be used with low-pressure air
(3) The public demand for balloon tires unquestionably will be so great that a large number of existing cars will be changed-over to use them
(4) The public will pay more for balloon-tire equipment because it looks better, rides better, brakes better and saves the car
(5) As soon as builders have learned what balloon tires will do for a car, they will be able to use lighter design and thereby save money
(6) The January, 1924, automobile show will include many cars equipped with balloon tires

THE DISCUSSION

QUESTION:—Is the name "Balloon Tire" appropriate? Why not use "Comfort Tire"?

J. E. HALE:—I did not like the name "Balloon Tire" and our company, also, hoped to get a more dignified name such at "Air-Cushion Tire." But everybody seems to say "Balloon Tire" and we cannot prevent it.

W. G. WALL:—Does the eventual fatigue of rubber have a large bearing on the life of the tire, or does the life depend on the fabric? By testing the rubber and the fabric in a machine, can definite statistics be obtained in regard to just the number of vibrations they will withstand?

MR. HALE:—I cannot give a definite answer as to the resistance to flexing of rubber that is not reinforced with fabric. My impression is that the ability of good-quality rubber to flex repeatedly is so great that it will continue to function in that way as long as the rubber is in good condition. We know that rubber, under stress, ages and becomes hard more rapidly than rubber not under stress. However, the cotton is the foundation of the tire. The rubber part will outlast the cotton part. The tire that wears out normally wears its tread off. We could increase the life of the tire by putting more tread on. We try, however, to build a balanced tire..

We recognize about 50 to 60 different types of tire failure. Flexing weakens the cotton, causing it to fray-out. Much of that action is in the side-wall sections of the tire. Obstacles, such as sharp sticks and glass often cut or pierce the tread rubber and get down into the cotton. That lets in water and dirt and the fabric begins to disintegrate slowly.

MR. WALL:—In these large tires a certain greater surface is being subjected to friction on the road due to the difference in speed of the different portions of the tire. Does that have a greater detrimental effect than on the tire that has a higher pressure?

MR. HALE:—The difference in the rolling speed of different portions of the tread of the tire manifests itself in a slight lack of uniformity of tread wear. It is customary to mount what we call a continuous "riding-strip" around the middle of the tire. This strip wears less than the row of non-skid buttons on either side. However, this effect is not necessarily detrimental to the life of the tire.

[a] See THE JOURNAL, July, 1923, p. 41.

This difference in the surface speed of the different portions of the tread undoubtedly has a desirable effect in improving the braking and traction characteristics of the tire, particularly on wet pavement, since the displacement action of the non-skid buttons produces a squeegee effect tending to wipe the pavement dry, thereby increasing the coefficient of friction.

MR. WALL:—Although more of the surface of these tires is on the ground, do we really have a better braking effect, due to the fact that the tire will come into contact with more obstacles than if it had only a small contact area? Is not the balloon tire more difficult to steer than the ordinary tire?

MR. HALE:—With any soft tire, it is, of course, more difficult to steer than with a highly inflated tire. This is the natural consequence of increasing the area of contact by 100 per cent.

T. VOORHEES:—Is a smaller wheel necessary on all cars equipped with balloon tires?

MR. HALE:—Consider a 33 x 5-in. tire. The rim diameter is 23 in. A 7.30-in. balloon tire is made as a substitute for this 33 x 5-in. size and, since this has a larger section, it is obvious that the wheel must be smaller. We do not want to increase the standing diameter of tires.

L. R. SMITH:—What is the difference in front-axle clearance with a flat tire?

MR. HALE:—A 5-in. tire drops, when becoming flat, 3.70 in. as compared with 4.75 in. for the corresponding balloon tire.

T. P. CHASE:—What is the effect of maximum braking as regards torsional stresses on the carcass?

MR. HALE:—Considering the tension in the cords, the increase is negligible compared to the air-pressure stresses. Rear tires wear out more quickly than front ones because they have from 30 to 60 per cent more load on them.

J. H. HUNT:—What changes can be made in steering to eliminate "shimmy" at the higher speeds?

MR. HALE:—When I first experimented with balloon tires I read the literature on "front-wheel shimmy"; but the more I read, the more perplexed I became, I have given up the solution of the problem. Much of the trouble lies in the steering-gear. We have had Ford cars equipped with balloon tires that would shimmy excessively at 15 m.p.h.; but when the back-lash was eliminated they would be all right. Having steering-wheels too free has a tendency to make a car "shimmy."

QUESTION:—How does the balloon tire wear in deep ruts and over rough spots?

MR. HALE:—A tire that has been run 15,000 to 18,000 miles will be worn but will have no cuts. Because the tire is soft and does not have such intense pressure back of it, it does not fight the road; it simply folds itself over. Running the tires against curbs does not injure the tires. One of the great troubles with most tires is the matter of tread separation. We have not had a single case of tread separation with balloon tires. While we have not had a winter's experience with these tires, I am sure that side-wall troubles will be negligible.

It would be foolish for me to argue that balloon tires will not puncture, but my experience indicates that the puncture trouble will not be excessive. Some of those who have had puncture troubles with balloon tires were simply unlucky. I have been driving almost a year and have not had a puncture yet. Mr. Putnam, of the Detroit Pressed Steel Co., drove 21,000 miles; he had three punctures.

MR. HUNT:—What happens to a balloon tire on a narrow country roads that compels driving in ruts?

MR. HALE:—It is not necessary to pay any attention to the ruts; drive right over them.

QUESTION:—What increase in mileage can be expected with balloon tires?

MR. HALE:—I cannot answer, because the balloon tires have not traveled far enough as yet.

CHARLES S. CRAWFORD:—Regardless of what an engineer thinks about the objections to balloon tires, his opinion will be over-ridden by the demand of the general public. I believe that the car-owner wants this kind of a tire, primarily on account of the improved riding qualities. We might as well pave the way for its use. The objection most talked of seems to have been hard steering. We have a certain standard of steering with conventional tires and a certain steering-gear ratio. This standard can be equalled with balloon tires by changing the ratio of the steering-gear. Frequently we receive complaints from customers of a car steering too easily, but the same car in the hands of another person was too stiff. In my opinion, the steering should be unusually easy and with this condition stiffer steering can be obtained merely by increasing the pressure on the ball-and-socket joints in the steering mechanism.

J. J. COLE:—In my opinion, there is the same difference in favor of balloon tires as compared with regular pneumatic tires as there is between solid and regular pneumatic tires.

R. H. HASSLER:—The experience of our organization with balloon tires has been limited to a few cars, but it shows very clearly the advantages of a two-way shock-absorber in stopping the peculiar "jiggly" action of these tires at the lower car speeds, or what Mr. Hale describes as a "choppy" action. We found that such a restraining device, adjusted to a low pressure, would overcome more completely this choppy action than when adjusted to a higher pressure. For example, cord tires would require a shock-absorber adjustment of 45 or 50 lb. per sq. in. to give the best riding qualities, while balloon tires on the same car would give best results at a shock-absorber pressure of only 30 lb. per sq. in. The two-way restraining-device would, in all cases, give far better results than could be obtained by any adjustment of the one-way device from very light to very heavy, even trying the latter at very high pulls of from 150 to 200 lb. In other words, very little shock-absorber control is needed to stop this peculiar action of the balloon tires, but it must be applied constantly, both up and down. When applied and adjusted properly in this manner, the results are very gratifying.

QUESTION:—Our experience with these tires is that when coming into contact with the ground, they roll-up and then snap out, making a great noise. What has been Mr. Hale's experience is this regard?

MR. HALE:—Some tire-treads are designed so that they have suction pockets, I have not had any experience with the noise mentioned.

The Nature of Matter

MID-WEST SECTION PAPER By H. B. LEMON[1]

PROFESSOR Lemon disclaims the general impresssion that the ideas of a physicist and of a chemist on the nature of matter are subject to continual revision and are never twice alike. The non-technical public, not having the background needed for proper evaluation, often considers as revolutionary changes and discussions which, as affecting the whole situation, really amount to a veritable tempest in a teapot. In truth, a new physics and a new chemistry have been built solidly and securely upon the foundations already established by past scientific work. The former conception of the structure of matter, that of molecules composed of atoms, still holds true; but new elements have been discovered and the atom is now conceived to be constituted of electrons held within the sphere of influence of a nucleus, in place of being considered inadvisable.

An outline is given of previous ideas of the nature of matter and the steps by which the present conceptions are reached are described and illustrated by analogies so that the mind can comprehend better the immensities of space and therefore realize in some degree the extremely small elements of substance structure. The theories and conceptions presented include valency, the photoelectric effect, the Edison effect, ionization, mass measurements, configurations of electrons for different substances, the Rutherford idea, dimensional conceptions, electrons and the atomic nucleus.

LEST you labor under a misapprehension, let me say at the outset that neither I nor anyone else, so far as I am aware, knows anything about this subject compared to what there is to learn. We have just begun to scratch the surface, and certainly no one realizes better than the physicist, or the chemist, how little we know.

I do not expect, nor have I been asked to make a contribution to your knowledge of fuels. I hardly expect that you will find any significant facts in my remarks that will help you in your own individual problems, other than the general fact that the more we know about the background of science and of nature in general, the more power and control we shall have in any special field. It is true sometimes that methods in wholly different fields become suggestive. I wish to correct a general impression that the ideas of a physicist and a chemist on the nature of matter are subject to continual revision and are never twice alike; and I have organized the remarks that I have to make mainly toward that end.

Scientific men lay great emphasis on the changes and modifications of points of view that are necessitated by the discovery of new material; and, of course, the discovery of new materials, the unearthing of new facts, is the essential work of the experimenter. The non-technical public, not having the background, often considers as revolutionary changes and discussions that really amount to a veritable tempest in a teapot. During the last quarter of a century there have arisen in the world a new physics and a new chemistry, not like a phoenix from the ashes of a conflagration, but rather like an edifice that is built solidly and securely on the foundations of the past.

In our high-school days, most of us were taught that an atom is the ultimate particle into which matter can be divided, that if we took a piece of chalk we could go on dividing it indefinitely until we came finally to a place where further division altered the properties of the thing we were dividing; in other words, we came then to the molecule, and a division of the molecule left us with component parts that were not like the original, with component parts that were atoms. Of course, that was purely an academic point of view; no one ever succeeded in dividing a substance until an atom was reached; it was only an abstract idea. We were taught that about 80 so-called different elements, by combination, composed all of the substances with which we were familiar. This picture is still before us, but we have now about 92 elements.

Mendeleef, the distinguished Russian chemist, in 1869 first formulated his periodic table of the elements, which most of us can recall from high-school days and which is still an essential part of the equipment of every scientific laboratory. The fact that chemical atoms are not all different was first discovered by Newlands and formulated more directly by Mendeleef a few years later.

If we take almost any atomic or molecular property and form a graph, arranging the chemical elements in the order of weight as ordinates against the property that we select, such as for example the absolute temperature of fusion, as abscissas, we get a curve that we see at once has periodicity. Or if the atomic volumes are plotted against the atomic weights, we have a curve that has successive peaks and, if we recall the chemistry of our school days, we may remember that lithium, sodium, potassium, rubidium and caesium are chemically similar elements and we notice that they occupy corresponding positions on the curve. These facts of course are very old and well known.[2]

If the chemical elements are put down in the order of their increasing atomic weights, after we write down seven of them, and seven ever was a magic number, the eighth has to be written under the first, the ninth under the second and the tenth under the third; at least, if we do that we shall have in vertical columns elements that have similar chemical properties. This is a very early shadow cast ahead by the portentous discoveries that lie just beyond the horizon. If these ultimate things, the atoms, are related, then there must be something more fundamental than them by which, or in terms of which, they are related. At any rate, there must be a mechanism that relates them, a mechanism that we think should be more fundamental than the things that the mechanism relates.

Michael Faraday, in 1833, formulated some facts that were equally significant, in the laws of electrolysis, and it is important to realize that the modern points of view are nothing but the developments of his early discoveries. Faraday, studying the conduction of electricity through electrolytes, or solutions of substances that became conductors of electricity, formulated three laws. The first

[1] Professor of physics, University of Chicago, Chicago.

[2] See New Knowledge by R. K. Duncan, p. 24.

of these is that the quantity of the substances decomposed is proportional to the quantity of electricity that goes through the solution. The second states that if different elements, such as carbon, copper or zinc, are involved in the electrolyte, the weights deposited out of the solution by equal quantities of electricity are strictly proportional to the relative weights of the substances themselves. In other words, if we have a substance that is twice as heavy as another, and both are in the electrolyte, the same quantity of electricity passing through the two solutions in series will deposit out of the solution that contains the heavier elements exactly twice what will be deposited out of the lighter element, provided the elements have the same chemical characteristics; that is, provided they both combine with hydrogen in the same fashion. But if we have one element that combines with hydrogen differently from another, in the sense that we associate two atoms of it with hydrogen where we associate one atom of the other with hydrogen, then, according to the third law, the weights deposited will not be proportional to the atomic weights alone, but will be proportional to the atomic weights divided by the valency. These laws are capable of but one interpretation, which identifies a definite quantity of electricity with an atom of matter. You see it is entirely immaterial, except for the valency integer, what atom of matter we select.

Valency

Let me give an example of what we mean by this idea of valency. If 200 people were carried from one locality to another by 50 automobiles, we should infer, if the automobiles were each filled equally, that they were four-passenger cars. In other words, the substance carried and the substance carrying would be related by the figure four which, in this case, would correspond to the valency. If, on the other hand, the people were observed to travel in 28 automobiles, we should be compelled to conclude that they traveled in seven-passenger cars and that four of them traveled in some other way. There would be no distinction whatsoever between the makes of automobile; the sole distinction would be in the carrying capacity. Thus Faraday discovered in all the various brands of element one essential property in which they were all alike.

These important contributions from the past constitute the foundation of our modern point of view. If atoms are related and are not all different, there must be something relating them. From Faraday's experiments, we suspect that this something is electrical in its nature. The twentieth century, then, found the stage set and ready for the discoveries to be ushered in. The most significant of these was the photoelectric effect discovered by Hallwachs in 1908, but not interpreted in its full significance until a little later.

Photoelectric Effect

To show the photoelectric effect, an electroscope is placed in front of a stereopticon, which projects it upon a screen. The electroscope consists of a metal plate having a bit of gold-leaf hung from it in such fashion that the gold-leaf hangs parallel to the plate being attached to the upper end. When a charge of electricity is put upon the leaf, the leaf projects because of the electrification on the plate and the rod on the leaf. Hallwachs observed that if a zinc plate were illuminated with ultra-violet light, any charge that the electroscope carried leaked away. When the plate is charged, one can see that there is, on the whole, no leakage; but if a mercury-arc light in a quartz tube is used, the illumination causes an immediate falling of the leaf. It was observed that this effect occurred only when the plate was negatively charged. The interpretation was, that if there is a negative charge on the zinc plate and the charge leaks off, it might be ascribed perhaps to the air or to the effects that the air has; however, after many months of patient investigation, it was found that the effect occurred in the highest vacuum that could be produced, that it was the same for different metals other than zinc and that it was purely a unidirectional effect. If the plate were positively charged, the effect did not occur. There could be only one interpretation of that. If the leaf is discharged, the electrification gets away; the electrification in the negative case must be negative electrification that gets away. There must be an emission of negative electrification under the action of the ultra-violet light. If, on the other hand, the plate were positively charged, it would appear that positive electrification does not do this. As a matter of fact, if the plate originally had no charge whatsoever but was merely exposed to the light, it was found to acquire a small positive charge. In other words, the action of the light was interpreted as releasing negative electrification. That release of negative electrification cannot go on indefinitely because, if negative electricity escapes from a neutral plate, it leaves the plate positive and, by the time the positive electricity has accumulated sufficiently, it has enough attraction for the negative electricity that remains to hold it to the plate, irrespective of the action of the light. So, the positive charge acquired by a metal surface under the action of ultra-violet light is conclusive evidence of the emission of negative electrification from the plate.

Another conclusive proof that there was negative electrification escaping was that other plates in the vicinity and in the way of this discharge were found to acquire a negative charge. Moreover, the properties were found to be wholly independent of the metals involved, except that the different wave-lengths of light sometimes were necessary to produce the charge. It could not always be produced by light of the same wave-length. As a matter of fact, it has been discovered recently that practically all the metals up to sodium show the photoelectric effect and that, with metals of the third series, particularly sodium and potassium, there is no need of ultra-violet light. Ordinary light, even red light, is capable of detaching negative electrification from sodium and potassium. That is the first significant discovery.

Edison Effect

The second discovery is attributed to Edison, who made it in connection with his experiments on the incandescent lamp. If an incandescent filament in a vacuum is connected through a battery and current flows through the filament so that the latter is heated to a sufficiently high temperature, we find that an insulated electrode in the side wall of the bulb connected through a galvanometer will acquire a charge and that current will flow through the galvanometer.

This can be demonstrated by using an ordinary incandescent-light bulb that has had its tip broken off. A blow-pipe is placed on the side of the bulb and a small hole is blown which is then filled up with sealing glass containing a platinum electrode. If the bulb is then sealed back to the vacuum pump and reexhausted, it will light in the usual fashion. When a connection is made with the positive terminal the current comes into one

side of the bulb; a wire goes from the other terminal to a galvanometer and the galvanometer is connected with the external electrode. There is no electrical connection between the galvanometer and the lamp in the sense that any current can go through the galvanometer, because this wire is insulated from the filament by at least 1 in. of vacuum. A vacuum is as high an insulation as can possibly be attained. Yet, if the excitation of the lamp is increased sufficiently current will flow and it is no small amount of current at that. Of course, this effect is the fundamental effect of the vacuum tube, which has become so important an adjunct of our modern civilization.

Here we have conditions that are essentially different from the photoelectric effect; yet they are equally significant. An ammeter in a circuit will show the current passing through the lamp. The sense of the deflection of the galvanometer shows that negative electrification is coming out of the wire, and that tallies perfectly with the photoelectric effect. Since the wire is negatively charged, compared with the other end of the galvanometer, if there is free negative-electrification in the space, it will be repelled from the filament to the plate. So, negative electrification travels across the gap, just as was described for the photoelectric effect.

Lenard and Lodge and Thomson and a number of others have studied the details of these two effects, and the interpretation was not long in being made. The emission was undoubtedly electrification. It consisted, it was found, of discrete particles, and these particles had identical properties irrespective of their source. In other words, whether they came from a carbon filament or a tungsten filament or a zinc plate or a copper wire, they were indistinguishable from one another; things were discovered that came from atoms, which were smaller than atoms and which were the same from all atoms. This, then, is the mechanism by which the atoms were to be related.

These particles, themselves invisible, make themselves visible in a variety of ways. If they impinge upon certain minerals they cause fluorescence. If, when sufficiently concentrated, they impinge upon a bit of platinum foil, they raise the temperature of the platinum to above the melting point. In other words, they possess mass, because they possess kinetic energy, and are capable, upon impact, of being converted into heat. They affect a photographic plate, they impart a negative charge to anything that comes into their path and they are capable, as one might suspect, of causing even mechanical effects.

When these particles are present in ordinary air they render it conductive. This can be demonstrated by replacing the electroscope I described above with another that is practically the same, but its outside terminal, or the case, is connected with the lower wire and the gold-leaf is connected with the upper wire; a third wire is connected to a gas-pipe that runs into the earth. The leaf is connected with the upper wire, and, by touching the upper wire, the electroscope becomes charged. The charge is maintained and the leaf is practically motionless, although the wire is passing out through the air; in other words, the air is non-conductive. But the air can be made conductive by lighting a match and passing it beneath the wire. As the match flame is passed beneath the wire, a deflection of the gold-leaf is noticeable. If the match flame is held under the wire, the deflection increases and the leaf is completely discharged; in other words, gases from an ordinary flame appear to render the atmosphere conductive. It must contain these particles of electricity. This effect takes place irrespective of whether the leaf is positively or negatively charged.

If the two wires are connected to two condenser-plates, and if a Bunsen-burner flame is held between the two plates, the leaf collapses instantly; in other words, we produce from a flame a much larger amount of electrification, as we should expect. If the leaf is charged and another pair of condenser-plates, placed a little closer together and one of them polished, are illuminated with ultra-violet light, the leaf also collapses. This may appear to be like the effect obtainable with a zinc plate but it is not, because the ultra-violet light does not necessarily have to shine on the plates now but merely on the air between them. The effect is not nearly so vigorous in the case of ultra-violet light. The moment the light is extinguished the effect stops.

A variety of other causes render ordinary gases conductive. If a small X-ray bulb is excited, the passage of the X-rays through the atmosphere also will cause a collapse of the leaf and that effect persists for 2 or 3 sec. after the rays are turned off; in other words, the electrification, or whatever it may be, of the air is much more vigorous than with ultra-violet light. A tube of radio-active material in the vicinity would cause this conductivity also.

Ionization and Mass Measurements

The mechanism here is precisely that of the zinc plate. The atoms of ordinary oxygen and hydrogen in the air, under the action of these various radiations, such as the chemical reaction of the high temperature and the flame, the ultra-violet light and the X-rays, have negative electricity detached from them; we have a group of atoms ionized, as we say. This means that a negative electrification is perhaps detached from one, which leaves it positively charged. In the presence of other atoms, this electrical particle does not remain isolated but attaches itself at once to another atom, which then becomes negatively charged; so, we have charges of atomic size. We have charged atoms and molecules of either size and, under the influence of the plates, one of which is positively and one negatively charged, the negatively charged atoms moving one way, the positively charged atoms moving the other way; and we have Benjamin Franklin's old two-fluid theory of electricity in action, that of positive ionization and negative ionization traveling in opposite directions.

These experiments show that not only metals but ordinary materials can be ionized and can be charged electrically. When ordinary atoms are charged we call those charged atoms ions. It is a term we have taken over from the old idea of conductivity in solutions. But we have conductivity in gases now. The sizes of the masses of these electrical particles have been measured, because the particles were found to be capable of deflection in a magnetic field, as one would expect electrical charges to be; in other words, they can be weighed by the centrifugal forces that are involved as they are swung round with magnets, in the same way that one can determine the mass of a stone by swinging it round one's head and estimating the pull.

There is a zinc-sulphide screen on the vertical plate in this discharge-tube which is fluorescent under the action of the negatively electrified particles, or electrons, as they are called. There is a small slit in a vein of mica immediately over the lower plate so as to make a narrow beam and, as the particles shoot upward, they leave a luminous trail on the screen. A bar magnet is capable

of deflecting the beam. If such a magnet is put behind the tube, the beam can be bent away from the screen, or back into the screen, because it follows the magnet around.

Without going into the mathematical details, the masses, the velocities and the charges on these particles can be measured from this simple experiment. The masses are found to be inconceivably minute; they amount to 10^{-27} grams. The smallest chemical atom that we know of, the atom of hydrogen, has a mass of 10^{-24} grams. So the masses of these particles are, as a matter of fact, 1/1845 that of the lightest atom. The velocities at which they travel in such a tube are prodigious, running from 10,000 to 100,000 miles per sec. The charge they carry is so small that it would take the entire population of such a city as Chicago, with every individual counting night and day for 2500 years, to count the number of them that pass through an incandescent lamp filament in 1 sec.

It appears that we are talking in large terms. We are. I assure you that in these phenomena one finds something of awe which corresponds to the order of the numbers involved. The strangest part of it all to me is that such insignificant chunks of carbon and nitrogen as ourselves are able to find out anything about these things. It is fully as astounding, more astounding in some ways, than our knowledge of the nebulæ that are so inconceivably far away. It makes one think that perhaps size after all is such a relative matter that it is almost a delusion.

Configurations of Electrons

If we have negative electrons coming from or composing all kinds of matter, how are we to think of their entering into composition? An analogy, which I wish to emphasize as nothing but an analogy, was suggested first by Sir J. J. Thomson, and experimentally improved later by Prof. R. R. Ramsay of the University of Indiana.

If some small steel balls are floated on a vessel of mercury beneath which is a magnet, the steel balls will be magnetized by induction from the magnet and consequently will be attracted through the region immediately above it, being free to float around. On the other hand, being magnetized alike, they will not get too close together because like kinds of magnetisation repel each other; in other words, these steel balls will be maintained in a certain region in the surface of the mercury by the attraction of the magnet beneath, but will be kept apart by virtue of their mutual repulsion. Thomson thought of an atom as some such sort of thing, originally a uniform sphere of positive electrification, which was merely another way of formulating his ignorance of what it was; something to hold these negative electrons together so that they would not fly to the uttermost corners of space by virtue of their own mutual repulsion. Understand, this is merely an analogy, but it is one of the most striking analogies in the history of science.

Such a vessel of mercury can be illuminated with the stereopticon arc and projected on a screen. If steel balls of 1/16-in. size, such as are used for ball bearings, are floated on the mercury, they will at once be attracted and be fairly mobile when the magnetic field is on. Two of the balls will arrange themselves, very naturally, at the opposite ends of a straight line. If a third comes in, it will form an equilateral triangle; a fourth will form a rectangle, usually a square; a fifth apparently causes a condition of uncertainty. There may be, in this last case, an attempt at an irregular pentagon, but with slight assistance one ball will go to the center and thus a square will be produced with a ball in the middle. That condition is not so stable as the other, and the irregular pentagon tends to recur. But with six balls there is no doubt; one will go to the center, and if a person should try to make a regular hexagon of that number of balls, he would not succeed.

As the number of balls is increased, the result is analogous to an atom being built up from its constituent electrons. But an atom would not stay still like that and let one look at it. If the magnetic field is removed, the result is that the parting of the balls at the center will cease and they will coagulate into a single mass. If an electrical current, a radial current, is sent through that configuration through the mercury, from an electrode at the center to a ring electrode on the outside, these steel-ball magnets will move in the electrical field and begin a perambulation around the central electrode, showing an analogy to the way in which electrons rotate, but the rotations are so slow that they really are not worth mentioning.[3]

The Rutherford Idea

More recent work has abundantly confirmed the ideas suggested in Thomson's earlier theory, but we must think of these atoms in three-dimensional configuration with their electrons in successive layers, such as might be likened to the successive skins of an onion, not at rest but moving with very great velocity and, from the point of view of Rutherford and some of the later investigators, we are led to certain convictions about the nature of the central nucleus that binds the thing together.

There is a central nucleus. Experiments on particles that are shot out from radioactive substances, scattering experiments performed first by Rutherford and Geiger, show conclusively that the central force binding these elements or electrons together was confined to a region in the interior of the atom infinitesimally small compared with the dimensions of the electron that formed its constituent parts. In other words, we have what is known as the Rutherford atom, in which we have the central nucleus of dimensions 10^{-15} cm. and electrons of dimensions 10^{-12} cm., whereas we have known for some time that the atom as a whole is of the order of 10^{-8} cm. (1 cm. = 0.3937 in.). The atom itself is only a few hundred millionths of a centimeter, but the electrons that fill the space individually are 10,000 times as small as the space they occupy. So, the picture of having a few grains of sand flying around in the interior of a cathedral is analogous to our picture of the atom; and the nucleus that holds these few grains of sand is 1000 times smaller than the electrons themselves.

Dimensional Conceptions

With regard to the size of the atoms, we rely for this number on data that are, on the whole, just as certain as ordinary data in astronomy, which tell us of the sizes, masses, distances and objects in the solar system. They are checked from half a dozen different points of view. With regard to the size of the electrons, we are not so certain, yet it is almost inconceivable that this dimension will be altered appreciably with respect to the other. In other words, we are not likely to revise our opinion of the relative size of the electrons and the space that they fill inside this little solar system, which is the atom. With regard to the size and the nature of the nucleus, we do not know very much as yet, but new facts are appearing in almost every number of the *Philosophical Magazine*,

[3] For details of these arrangements, see *Physical Review*, vol. 34, pp. 242 and 243.

Proceedings of the Royal Society, Physical Review and the current scientific journals.

Let us illustrate further our ideas of these things in a very crude fashion. Suppose we imagine one of our leading scientists as being magnified so greatly that he could stand on the earth and bump his head on the moon; in other words, enlarged so that his 6 ft. of height becomes 250,000 miles; further, in order that he shall not be lonely out in space we give him his laboratory and all his materials proportionately enlarged. With such an increase in the size of his world, his atoms would be brought within the ken of us who remain as formerly; for to such a man, an atom would appear as a circular region in space, 4 in. in diameter. Now, by using a microscope, we might be able to find the electron in his space, because its size is of the order of 0.001 in. It would be something more than 0.001 in., a quantity easily measurable under a microscope. The electron would be inside this space, which is a 4-in. sphere representing the atom, and in which we would see nothing else; yet no other atom could come into this 4-in. sphere of space because of the tremendous influence that the electron has over the space. That 4-in. sphere of space is like a solid particle; under ordinary conditions it is not to be penetrated by another space just like it. The electron goes around so fast in it that we can say it is everywhere at once and keeps everything else out. The nucleus of the system, however, would be utterly beyond our ken still, because it would amount to less than 0.0000001 in. in diameter.

Let the scale expand and become a little larger; we must get at the size of that nucleus. Let the 4-in. atom now become as large as the earth and, still expanding, fill the entire orbit of the earth, so that our atom is now a space 186,000,000 miles in diameter. The orbit of the earth round the sun is now our atom. In that orbit a body the size of the earth can represent the electron. The electron has swelled considerably, you see, by the enlargement. The nucleus at the center is not like our sun, an object prodigiously large compared to the earth, but a tiny sphere 4 miles in diameter.

In terms of this imaginarily enlarged atom, how large has our imaginary man grown to be? We started out with a man who reached from the earth to the moon. On this scale, the man would have a height greater than 10^{17} miles. A light-ray travels less than 10^{13} miles in a year. It was measured first by Professor Michaelson as having a velocity of 186,000 miles per sec. A beam of light is the swiftest means of communication that we have. It can travel eight times round the earth in 1 sec., to the moon in 0.18 sec., to the sun in 8 min. and across the entire solar system to the orbit of Neptune in 8 hr., traveling in an entire year 10^{13} miles, that is, only $1/10^{5}$ of the entire abscissa. In other words, the height of the man on this scale would be greater than 10^{4}; that is, between 10,000 and 100,000 light-years. Now 100,000 light-years would more than bridge the entire known universe of stars. So we come to conclusions that are stimulating to reflection, even though the figures are more or less amusing. We look out into space and we look into the interior of things that are about equally far apart. It is still as absurd as it was in the time of Copernicus to assume that we are placed at the center of this pageant. I myself prefer the conviction that its boundaries are set merely by our own human limitations. It is curious that we see about the same number of powers of 10 each way, because it shows that, on the whole, we have been about as active in one direction as in the other.

THE DISCUSSION

DR. H. C. DICKINSON:—Subjects that members of the Society have been very much interested in for the last 2 or 3 years have very close connection with some of the things Professor Lemon has spoken of. I refer particularly to the phenomena that occur in the combustion of fuels. We have learned some very important facts. Thomas Midgley, Jr., has talked to us many times about the very interesting features of this performance. I believe we shall not be able to answer all the questions that Mr. Midgley's results have raised until we apply ourselves much more fully to some of the things of which Professor Lemon has told us.

H. L. HORNING:—I experienced great satisfaction in witnessing Professor Lemon's demonstration of the Edison effect, particularly because, in 1898, I recognized the same effect in the laboratory and utilized it in dissecting the waves sent off from a static discharge. We were condensing an electric charge in a number of Leyden jars connected with a static machine, and were using this discharge to produce the yellow line of sodium in the spectrum. I had to pass over to the other side of the laboratory and saw an incandescent-light bulb lying on a table. Every time the spark jumped, the bulb lit with a phosphorescent glow. Realizing that this was due to radiation, I picked up the bulb and walked away with it. Then I thought that possibly if I put a little tinfoil on the tip I might magnify the effect. I was able that year to send a message something like 120 ft. through the walls of the institution. I shall always look upon that as one of the great moments of my life because, unknown to me, I was merely sending a wireless message and receiving it by the very methods that are effective today. This was a great lesson also, for while the world eventually reaps its reward from new ideas, the great benefits come from the successful efforts of the men who bring the ideas to practical usefulness.

I was particularly interested also at that time in the decomposition of water and made another discovery that I never used. When I put two electrodes under water and decomposed it with the electrodes very close to one another, there was very rapid decomposition at the tip; as a matter of fact, the oxygen and the hydrogen were intermingled. An intermittent process was set up by which oxygen and hydrogen were suddenly formed and the current was interrupted. As Professor Lemon has said, the electrons of which the current is composed have inertia; they also have weight; therefore, they would not stop. They jumped across the gap in the form of an electric spark and started the process of combustion; the oxygen and hydrogen united again, forming water, and then decomposed again into oxygen and hydrogen. The operation repeated itself with great rapidity. It made a beautiful effect under the water, because it showed a little arc-light that we were all satisfied was fire under water. We understood it perfectly but did not use it. A year later I found that Professor Wehnelt, of Germany, had used that as an interrupter for the X-ray machines that were being developed at that time. I think it is used even to this day.

I was interested in Professor Lemon's discussion of photoelectricity, as I have always recognized that effect inside the internal-combustion engine. I found that a zinc plate is charged when bombarded by the radiations of the explosion.

P. S. TICE:—Has Professor Lemon attempted to shed a little light on some of our fuel problems along the lines of his paper?

PROF. H. B. LEMON:—No. We are not an engineering laboratory, and the only opportunity that we have at present for investigating internal-combustion engines is on one very small four-cylinder, four-cycle marine engine that is used in one of our elementary courses. I am giving an advanced laboratory course in heat, and we certainly shall become interested in some of the more modern problems of experimental thermodynamics. I shall welcome suggestions regarding the fuel problems that you are endeavoring to solve.

MR. TICE:—Thomas Midgley, Jr., talks about "hitting this animal on the head and breaking it into parts." Prof. C. A. Norman tells us about "shaking the snake apart." Can an analogy be given? In this decomposition of water we get a long chain compound; we say, we hit it on the head and combustion starts. Can a picture of that sort of thing be given that will help us?

DR. HERMAN SCHLESINGER:—I understand that you are interested in some picture of how a long chain compound, for example, of a hydrocarbon like gasoline, is decomposed in the spark or during combustion. There are a number of theories at present with regard to the way such combustion takes place, two of which are probably the most suggestive. One is that the compound, being a long chain, has some weak point and that, with the increased agitation of the molecules and of the atoms within the molecules that occurs at a high temperature, the long chain arrangement becomes weak, breaks apart and leaves some atom or group of atoms which, let us say, has not got all the corners of the Lewis-Langmier cube fitted up and which, therefore, takes on or draws near to it some of the electrons of some other atom, for example, the oxygen atom. The other theory, for which there is not so much evidence, is that the oxygen atom or the oxygen molecule first adds on to the whole chain in some way that we do not yet understand, and that then a breaking occurs in some place. It is a very characteristic thing that a number of chemical reactions which we are accustomed to think of as taking place very readily are easily prevented. For example, you are familiar with the fact that if we put sodium, which is an extremely active element, into an atmosphere of chlorine, a very vigorous reaction results; that if we place sodium in contact with the air or with pure oxygen, it oxidizes extremely rapidly; or, for example, that ammonium chloride, when it is heated, decomposes into ammonia and hydrochloric acid. It is found, however, that if we put sodium into dry chlorine, the sodium and the chlorine will not react; and that if we take ammonium chloride, dry it, for example, over phosphorus pentoxide so that all of the moisture is gone, and then heat it, volatilization will occur without decomposition. If we take phosphorus and expose it to dry oxygen it will not burn; at least not unless you heat it to a fairly high temperature.

It strikes me that catalysis is a matter of extraordinary importance in the problem of the internal-combustion engine. I know very little about what has been done with regard to the internal-combustion engine, but the extremely important problem of the future is not merely the study of the simple chemistry of the combustion of the hydrocarbons in an engine cylinder, but the effects that catalytic actions, which are bound to be present in carbon deposits and the rough metallic surfaces, will have upon combustion.

PROF. DANIEL ROESCH:—I am seriously impressed by the importance of this subject and the mode of treating it in relation to the automotive industry. The coordination of information of this kind with that used by engineers will bring the ultimate result. I think that in 5 or 10 years from now the importance of it will be seen. Cooperation by the chemist, the physicist and the engineer is bound to clear up the situation.

MR. HORNING:—I would like to have Professor Lemon and Dr. Schlesinger consider a combination of oxygen and hydrogen and discuss the mechanism whereby a very high-frequency radiation may loosen the bond of hydrocarbons and thus facilitate their combining with oxygen. Our engineers are at the point where they would like to understand the fundamentals of this process.

COMBUSTION

DR. SCHLESINGER:—That is a question which just at present is one of those most discussed in physical chemistry. I will point out the way in which that question has come up in chemistry and the lines along which it is being developed at present. We all know that the higher the temperature is the more rapidly will a chemical reaction take place. Imagine a chemical reaction, say between the gaseous substances A and B. The molecules of A and the molecules of B are moving about at high speed, and occasionally a molecule of A and a molecule of B come together, with a chemical reaction as a result. We know that if we raise the temperature we shall increase the velocity of those molecules and, therefore, we can understand that the speed with which the chemical action takes place should increase with the rise in the temperature. When we actually measure the increase in the speed of the reaction with the rise in the temperature, we find that the increase in the speed of the reaction is many hundred times greater than he can account for simply upon the assumption that it is due to the increase in the speed of the molecules. How shall we account, then, for the fact that the velocity of the reaction increases so much more rapidly with a rise in the temperature than it should increase according to the purely increased speed of the molecules? We may assume that there are for each kind of substance, let us say, two kinds of molecule, or two states in which the molecule may exist, one in which the molecules are active and the other in which they are passive.

In the chemistry of 10 years ago, we should have said that perhaps some of the double bonds in a carbon compound had been ruptured, but we are beginning to inquire more deeply into the phenomenon of activation. There is a great probability that each molecule has a certain definite vibration-frequency and that if we put into the molecule energy of a wave-length that is capable of harmonically increasing the vibration-frequency of that molecule, we shall make it react more readily. Consequently we find two effects: (a) that certain substances are sensitive to light-rays in a certain way; for instance, we know that the photographic plate is much more sensitive to the shorter wave-lengths than to the others; and (b) when we put energy into a system by raising the temperature we increase the amplitude of those vibrations and, therefore, make the tendency to rupture the molecule greater.

The same problem is involved in the question which, as I have pointed out, is of such great importance in the combustion of fuel in the internal-combustion engine, namely, catalysis. Why should certain substances merely by their presence be capable of increasing the velocity of the reaction? They can do so in many ways, but one way is by being able to absorb radiation of a particular frequency and to give out radiation of a frequency that will increase the vibration amplitude of a particular molecule.

These, at present, are theories that have not yet been fully or I may say even partially established, but some of the chemists are working very actively along these lines.

CHAIRMAN O. B. ZIMMERMAN:—The one thing that we should carry away from this meeting is that altogether too often in our engineering societies we follow questions from a purely mechanical standpoint. It has been shown tonight very clearly that chemistry and physics can enter into our problems and our understandings much more extensively than they have entered in the past. The real development in internal-combustion engines in the automotive industry, or in any other industry for that matter, is the application of the principles that are worked out in institutions such as the University of Chicago and by such coordination as we have had between Professor Lemon's excellent scientific conceptions and our engineering reactions from the mechanical standpoint.

IRRIGATION DEVELOPMENT

RECLAMATION projects must be developed with due consideration to the ability of the reclaimed land to compete on an economic basis with other cultivated land, and to the total output of American farm products in relation to the probable demand for them. The problem is one of peculiar interest to most of the States beyond the Mississippi, as the western two-fifths of the United States, embracing parts of the Dakotas and the tier of States immediately south of them and all the territory westward to the Pacific coast, is a region of deficient rainfall. For the most part it has an annual rainfall of less than 20 in. Corn-belt lands east of the Mississippi receive from 30 to 40 in. annually, while the fall over considerable areas farther east is as high as 60 in. In addition to the scantiness of precipitation in the large western area, the seasonal distribution is such that full benefit is not received in the growing season. West of the Rockies most of the rainfall occurs in winter. Within the area described variation in the quantity of precipitation occurs, but, while some favored regions west of the Rocky Mountains and on the Pacific coast receive more than 30 in. annually, in another larger area less than 10 in. is the rule, a condition comparable to that found in the Sahara Desert.

On the authority of the United States Reclamation Service, it is stated that "under the most complete system of irrigation possible it is probable that not over 5 per cent of the arid land can be irrigated in any one of the Western States." A half century of irrigation by private enterprise preceded Government entry into the irrigation field through the passage of the Reclamation Act in 1902, and nearly 9,000,000 acres of land was receiving an artificial water supply at that time. To a very limited extent the States had promoted construction of works, but difficulties in financing hindered its progress.

A summary of irrigated lands included in the Census of 1920 shows over 19,000,000 acres of land in 19 States actually irrigated. This includes enterprises of all kinds, both public and private. Improved farm-lands in the United States included 503,000,000 acres at the close of 1919. One-third more land than was actually supplied in 1919 can be watered without the construction of any new facilities.

The years 1920-21 and 1921-22 provided a severe test of the economic stability of the irrigation works. The irrigation farmer has a heavier financial burden than others, as the annual charges for operation and maintenance of the irrigation system continue whether the farm is paying or not. These are in addition to the installments payable on construction charges. For the years 1920 and 1921 the situation of many of the farmers on Government projects was so serious that relief acts were passed by Congress in 1921 and 1922 to enable them to continue operations. None of the accrued charges was remitted, but authorization was given to suspend the rule that water service be discontinued where payments were in arrears for more than a year. Normally some deficiency in payments occurs each year, but a considerable increase occurred in the 2 years mentioned. The average value of farm lands in Kansas was about $55 per acre in 1919, in Iowa nearly $200 per acre and in the Country as a whole, $57. Arid land has been made productive in the past at a cost of at least $60 per acre on the average for those projects that have received Government supervision.

Where the product of irrigated lands is sufficient to earn on the larger capitalization at the average rate on non-irrigated lands, the investment is profitable. Taking into consideration the probable higher cost of successive Government works, only lands of high productivity should be developed. Otherwise, the project farmer will find himself handicaped at the start in competition with the majority of producers.—*Commerce Monthly.*

THE ONE-CROP FARMER

AMERICA can never be made safe for the one-crop farmer. He will always be "in hot water" and in politics. His extremity will always be the political demagogue's opportunity to be elected to an office. Fundamentally, the woes of the one-crop farmer are the fuel and the flame of the Farmer-Labor party movement.

America never has been and never is likely to be unsafe for the farmer who practices diversified farming, the keystone of which is live stock. Firmly established and even today comparatively prosperous in many regions in many States, diversified or mixed farming, which always and everywhere is based on stock raising, is the Nation's greatest asset and chief safeguard in a time of economic and political upheaval.

The overwhelming majority of American land-owners are neither specialists nor wheat farmers. So long as mixed farming, with its foundation based upon improved live stock, continues to increase, as it has been rapidly increasing in recent years, American agriculture cannot be "ruined" by unprofitable prices for wheat.—*Breeders Gazette.*

Discussion of Papers at the 1923 Production Meeting

THE discussion of many of the papers presented at the recent Production Meeting of the Society, which is constituted without any exception of the remarks made at the meeting, is printed herewith. Another feature that is worthy of comment in this connection is the large number of question cards handed in.

For the convenience of the members, a brief abstract of each paper precedes its discussion. Members who desire to refer to the complete text as originally printed and the illustrations that appeared in connection therewith can do so with a minimum of effort by consulting the index on the first page of the November issue of THE JOURNAL, as all of the papers for which discussion is given below were published in that number.

SPUR-GEAR GRINDING AND TESTING

BY A. J. OTT AND C. L. OTT

A GRINDING machine for finishing spur-gears is illustrated and described; claims are made that it will grind transmission gears on a production basis after they have been heat-treated, will produce correct tooth-contour, smooth finish and accurate tooth-spacing, these features being necessary in producing gears that are interchangeable and that run quietly.

This machine is of the generating type, its action being that of rolling a gear along an imaginary rack and using the grinding wheel as one tooth of the rack. The dished grinding-wheel is reversible, 30-in. in diameter, mounted below the gear, and can be swiveled to the right or left of the center position up to an angle of 25 deg. The work-spindle carries the indexing and the generating mechanisms at the rear, where they are accessible and yet are protected. Two or more machines can be operated simultaneously by one man, as a clocklike mechanism can be set to stop the work-carriage and the grinding wheel when the last tooth of a gear has been ground.

A drum-cam drives the work-carriage. Thin steel tapes are used to accomplish the generating principle; they wind and unwind on a pitch-diameter segment as the work-carriage is driven forward and backward, and produce uniform duplication of tooth-contour. Slight variations of tooth-contour can be made easily by giving a greater or a less angle to the wheel and also by varying the diameter of the pitch-circle or segment.

A machine for testing gears that have been ground is described also; it will develop the involute curve, indicate whether it is true or modified and test tooth-spacing. By means of adapters, engine-front spiral-gears, and bevel-gears, can be checked for accuracy of contour and for tooth-spacing.

THE DISCUSSION

CHAIRMAN JOHN YOUNGER:—An interesting thing brought out by Mr. Ott is that if we grind gears it will eliminate the tear-downs to a large extent, such as the overhaul work in transmissions. We are getting to the point in automobile construction where we are looking all the time for longer life of the parts. If we can take off a slight quantity of metal that causes interference, noise and wear, we will obtain a longer life for our transmissions, axles and timing-gears.

QUESTION:—How much is removed from the pitch-diameter in the grinding time required per tooth?

A. J. OTT:—Usually from 0.003 to 0.005 in.; sometimes only 0.002 in. The time required on the usual transmission tooth is 5 or 6 sec. per side of tooth. That is one grinding, or once around, which includes the in-and-out movement of the tooth to the wheel. Usually the operator goes around the gear twice.

QUESTION:—What is the limit of face-width on gears ground with your machine?

A. J. OTT:—For a six-pitch gear, it is 2 in.

QUESTION:—Why do you use a 30-in. diameter wheel?

A. J. OTT:—The 30-in. wheel is used so that we can grind up to a 2-in. diameter.

QUESTION:—What would be the daily production in 8 hr. on the gear first shown?

A. J. OTT:—That depends upon distortion and how many times it is necessary to go around the gear.

C. L. OTT:—It depends also on whether we want to grind the gear on both sides and how many machines the operator can use. On a 33-tooth gear, a man could easily run three machines, if he had that many available; if he had only two machines, the grinding time there should allow him to accomplish about seven or eight gears per hr., two grinds per side, which, in an 8-hr. day, would be 64; it would be about from 55 to 60 per machine. If we want to grind both sides, we can do that with two machines, or double the production if only one side is ground. A higher speed than this is maintained in one installation. This is 14 teeth per min. on a six-pitch gear, or 10 gears per hr. per machine.

QUESTION:—How are wide-face gears ground?

C. L. OTT:—Our machine will not grind over 2 in. on a six-pitch gear, and the average transmission gear is not that wide. This machine is made for that job. The average transmission gear is from $\frac{5}{8}$ to 1 in. wide.

QUESTION:—Is it necessary to true the wheel while the gear is being ground?

C. L. OTT:—If we had to true the wheel while the gear is being ground, the grinding machine would be no good. We use a 30-in. wheel, which provides almost 8 ft. of abrasive surface. There is no particular wear when the gear goes around once; it is impossible to detect it.

QUESTION:—Is it necessary to reverse the wheel to grind both sides of the tooth?

C. L. OTT:—It is not necessary to do that if the gear can be reversed. Reversing the wheel is necessary only in the case of stem gears and where it is desired to retain the same holding arbor. If we wish to reverse the

stem gear and hold it with an outer support, we can do that too; but we do not advise that because it is very unhandy.

QUESTION:—Can spiral gears be ground on this machine?

C. L. OTT:—No; it is only for spur-gear grinding.

QUESTION:—How many teeth can be ground with one dressing of the wheel?

C. L. OTT:—I should say that on the six-pitch gear, with ordinary care, about 60 teeth should be ground with one dressing; after going around a 33-tooth gear twice, it would be advisable to dress the wheel. It depends also upon how good a wheel is being used.

QUESTION:—How are cluster gears ground?

C. L. OTT:—The cluster gear is usually made with the largest gear loose. The middle gear can be ground and then the largest gear can be ground in place after it has been riveted-on or ground before it is riveted-on. We can grind two gears in a cluster of ordinary design.

QUESTION:—What do you consider a commercial amount of backlash for a ground gear?

C. L. OTT:—The engineer at the motor-car plant usually tells us how much backlash is desired. I would say that, with closely held limits, on transmission cases, about 0.003 in. on each gear is sufficient.

QUESTION:—What are your grinding tolerances?

C. L. OTT:—We can hold a gear right up to size, provided it has sufficient stock. Taking a gear with oversized teeth, we can clean-up this gear after hardening and then test it for backlash. If, say, it is 0.002 in above the limit, we can put it in the machine and take off the 0.002 within 0.00025 in. at least. As for tooth spacing, we hold limits of 0.00025 in. tooth-to-tooth and use a 90-deg. check and 0.0015-in. accumulated error.

QUESTION:—How are bevel gears tested for involute curvature?

C. L. OTT:—We cannot do that on this machine. We can chart the tooth curve and test the tooth spacing.

QUESTION:—What is the approximate additional cost of grinding all the teeth of ordinary automobile transmission gears?

C. L. OTT:—I take it that the question means labor cost, leaving out overhead. Taking a six-pitch gear for example and averaging eight gears per hour on both sides, all the way through, if the man were paid 80 cents per hr., it would be around 10 cents per gear. That would be rather high; say from 8 to 10 cents to do that on each gear. Usually six gears in the ordinary transmission are ground and the labor cost would be about 50 cents.

QUESTION:—How do you keep the cutting plane of the wheel exactly at the theoretical line of contact as the wheel or the diamond wears?

C. L. OTT:—Suppose we rolled a pinion along a rack. In like manner, so long as we roll the gear against the grinding wheel, roll it far enough out when it reverses and roll it back again, it will give the same curve. We have moved the wheel as much as ¼ in. lengthwise, and maintained that rolling, and no difference was noticed in the curve. So long as the roll is maintained, there is no particular point there.

QUESTION:—Is reduction of noise the chief advantage of grinding gears?

C. L. OTT:—Everybody wants noise eliminated in motor-cars. Some think that durability is a good feature. One would rather get a gear for 60 cents than pay $1. There are three benefits from grinding: economy, elimination of noise, and durability.

QUESTION:—Does grinding increase the load that can be carried by providing more uniform contact?

CHAIRMAN YOUNGER:—That is perhaps expressed by saying that the same load can be carried, but for a much longer time. That gives durability, the matter of long life, that is a large factor in automobiles just now. The life of cars is increasing steadily. Formerly, the average life was about 5 years. It is now in the neighborhood of 7 years and the curve of life is rising right along. Just such things bring this about.

QUESTION:—Does the wheel travel across the face of the tooth?

C. L. OTT:—The wheel does not travel at all; it revolves only.

QUESTION:—Will the gear-grinding machine accommodate gears of any involute form of standard or special pitch?

C. L. OTT:—I think it will; certainly it will, if they are within any reasonable limits. We can grind a modified involute form, and any pressure-angle up to 25 deg.

QUESTION:—Can the wheel be dressed during the grinding of a gear and still retain accuracy?

C. L. OTT:—I think that it would not be advisable.

QUESTION:—What method do you use to dress the grinding wheel?

C. L. OTT:—We have a double-worm hand-driven truing-device that is very substantial in design. It has a rocking motion. We have experimented with slides for truing, but the grit gets in. We have eliminated all of that trouble by making a lever-action device.

QUESTION:—Why do you follow the tooth form of a green gear instead of establishing a master form on the grinder?

C. L. OTT:—That point is raised by the manufacturer who has gears out in service, on account of his repairs. He would like to have the same curve sent out, so we are required to grind that curve. We think it is all right if the gears run quietly.

QUESTION:—A grinding finish was said to depend upon the amount of backlash desired. In what way?

C. L. OTT:—The only relation between backlash and grinding finish is that, if gears are cut with the desired backlash and we are expected to true them up afterward, more backlash results; that is all.

CHAIRMAN YOUNGER:—In other words, you must have a full-stock gear.

C. L. OTT:—We should have a small allowance, say 0.002 or 0.003 in. on the side.

QUESTION:—If noise is not a factor, what can be said as to the wear of teeth that are ground and those that are unground?

C. L. OTT:—We have statements from two large engine companies in Detroit. They say that, from actual tests, the ground gear lasts far longer than the unground gear.

QUESTION:—Does a true involute curve produce a quiet gear?

C. L. OTT:—We have found by experience that, if no eccentricity in the spacing of the teeth occurs, the curve can vary somewhat and we still get about the same results so far as the perfect involute is concerned. I feel that the curve ought to stay a little bit away from that.

QUESTION:—Have you made any advance in regard to bevel grinding?

C. L. OTT:—We have not taken up that proposition yet.

QUESTION:—What is there to stop water from getting between the grinding wheel and the bearing of the spindle?

C. L. OTT:—Because the wheel is below the work,

water or anything of that character will have a tendency to get into the bearings, but we have that well safeguarded. We have two splash-rings there and rely on centrifugal force to help us out; also, we use a double packing-ring. We have no trouble there.

QUESTION:—Were the tooth curves shown taken from production or from an experimental test?

C. L. OTT:—From production.

QUESTION:—Is the cutting face of the plane a plane surface only?

C. L. OTT:—Yes.

QUESTION:—Is that modified at all?

C. L. OTT:—There is absolutely no modification.

CHAIRMAN YOUNGER:—Do automobile manufacturers pay any attention to securing quiet gears in England?

W. HADLEY[1]:—Certainly. Owing to the high speed at which the English engines run compared with those of the American cars, we have to get down to this very thoroughly.

CHAIRMAN YOUNGER:—They do much gear-changing in Europe. Do they insist upon quiet second and third-speed gears?

MR. HADLEY:—Yes.

CHAIRMAN YOUNGER:—Is that obtained by grinding, by care in manufacturing or in other ways?

MR. HADLEY:—That is taken care of by grinding.

DEVELOPMENTS IN PRODUCTION GRINDING IN THE AUTOMOTIVE INDUSTRY

BY OSCAR A. KNIGHT

IN production grinding the progress made during the past few years has been along the line of grinding multiple parts simultaneously, such as piston-rings, ball and roller-bearing cups and so forth. This kind of grinding brought about the use of wider wheels to cover the entire surface of the work, whereas formerly narrow wheels had been used with the traversing table method. With the development of these operations came the cylindrical grinding of square and distributor cams; also square shafts, using the oscillating cam-grinding attachments; piston-relief grinding with the same attachments; and two-wheel or double-wheel grinding for such parts as steering-knuckles and pinion shafts of different diameters or where two diameters are separated by some protrusion, as in steering-gear worm-shafts.

To accomplish these new operations more care has been taken to build machines that are heavier, stronger and more accurate so that operators can place greater dependence upon the mechanisms than was possible with previous machines. Greater care has been taken to balance the grinding wheels more accurately to overcome imperfections in finish and to eliminate excessive repairs on the grinding machine itself. Some of the new attachments, mechanisms and grinding machines are described in detail in the paper.

In conclusion the author states that the automotive industry has become the chief element in machine-tool business in the Country at the present moment and therefore the principal factor in forcing new developments in machine-tool design. He also points out the importance of a quality product to serve the needs of the automotive industry adequately.

THE DISCUSSION

CHAIRMAN JOHN YOUNGER:—Originally, crankshafts were very small in diameter. We made them as near the minimum size as we possibly could. Then we increased their diameter. We were satisfied with this for a while, but this year there has been another general movement toward again increasing their size. In our big-diameter crankshafts, to what extent are we eliminating the use of the steady-rest while grinding? Is it possible to do away with it?

O. A. KNIGHT:—Several factories run their machines without steady-rests; but their production is very small compared with that of those who support the pins with a steady-rest.

CHAIRMAN YOUNGER:—Does that mean that the thrust of the grinding wheel is greater than the explosion thrust?

MR. KNIGHT:—A wide-face wheel will force the work away from the cutting surface of the wheel unless we back the work up. The length of the work being done should be as short as possible between centers; the purpose of the steady-rest is to hold the work on the center line. It eliminates the vibration of these heavier shafts, which vibrate more than the lighter shafts did.

CHAIRMAN YOUNGER:—Then, in future design, we will have to consider tooling reactions as well as the reactions in the machine.

MR. KNIGHT:—Yes. I believe we shall always have to support a crankshaft with a steady-rest to make it as round, straight and smooth as is demanded by the trade.

QUESTION:—What means have been developed to balance grinding wheels?

MR. KNIGHT:—Several means are provided for balancing wheels. The right way to balance a wheel is to balance the wheel itself. If it were possible for wheel-makers to puddle a wheel in such a way as to cause a uniform balance throughout its life, that would be ideal. That has been accomplished on an experimental basis but it has not been carried out in production. Eventually, no balancing devices on the machine itself will be required, because the wheel that has been made true to its respective size will be in balance throughout its life. Lead has been placed in one side of a wheel to offset a heavy side opposite, but the wheel sleeves that hold the wheel have been equipped also with balancing flanges. The wheel is in balance when received by the user, but as it wears smaller during its use, it sometimes goes out-of-balance and must be rebalanced.

QUESTION:—What limits for pin-axis and shaft-axis alignment do you consider possible?

MR. KNIGHT:—Anything less than 0.002 in. will retard production, but I believe that 0.002 in. is a good figure to consider as a good productive product from good crankshaft machines.

QUESTION:—Do you consider lapping after grinding necessary on crankpins?

CHAIRMAN YOUNGER:—I have heard recently of a machine for buffing crankpins that is very similar to a grinder.

[1] English representative, Lees-Bradner Co., Cleveland.

MR. KNIGHT:—Many different qualities of crankshaft are made. The automotive engineer decides whether he wants the *quality* of crankshaft that costs more. The buffing operation is, however, a good one. It takes off the feathers or fuzz and prevents that from going into the bearing of the connecting-rod or the bearing of the crankcase itself. Every revolving shaft in a certain engine is buffed in the direction it rotates in the engine. The designer of the engine says that eliminates much bearing wear and bearing trouble that would occur if the shafts were polished or buffed in the opposite direction.

CHAIRMAN YOUNGER:—It is understood, of course, that such lapping or buffing must be done with the same accuracy as the grinding is done.

MR. KNIGHT:—I have known of work being called buffing that was not buffing; it injured the pin as it came from the grinding machine, rather than having improved it. If correctly performed, buffing is an improvement after the average medium-rate crankshaft has been finish-ground. I believe that the crankshafts for the best grade of car should be lapped by the old-fashioned lapping method. Buffing will never make a perfectly round object. It will follow the shape that has been made in the grinding machine, and all products from grinding machines are not perfectly round or perfectly straight; but they are within limits of accuracy that are satisfactory to the maker of the product.

CHAIRMAN YOUNGER:—What is the wheel cost for a 2-in. shaft, for example?

MR. KNIGHT:—I cannot state exactly. The rough-grinding on pins costs 4 cents per pin; roughed from the black stock. That includes diamond and wheel costs.

CHAIRMAN YOUNGER:—Is the wheel cost almost negligible in the cost per shaft?

MR. KNIGHT:—Yes.

QUESTION:—How much does the oscillating wheel travel?

MR. KNIGHT:—Nothing would prevent them from traveling ½ in. if that were found necessary, but any movement from 1/32 to ⅛ in. is sufficient to break-up the grain lines, for which purpose the attachment was developed.

QUESTION:—Is the trend toward centerless grinding-machines where larger limits are allowed?

MR. KNIGHT:—The trend is great toward the centerless machine.

CHAIRMAN YOUNGER:—Does it mean differences in tolerances and limits?

MR. KNIGHT:—Just as close accuracy can be secured from the centerless machine, if great care is taken in preparing for the closer limits. The greatest production from centerless-machine grinding will be secured with wide limits for accuracy and finish. The centerless machine is doing wonderful work today in the grinding of pieces that have no centers or pieces where center-holes can be removed. I know very little about centerless grinding except what I have observed, but I think the direction of a large volume of work is toward semi-automatic, automatic and centerless grinding, but centerless grinding has a limit as well as crankshaft grinding or any other kind. Production on piston grinding has a limit because the wall of the piston is either thick or thin. If it is of cast-iron or steel, and those limits have to do with centerless grinding as they have to do with all other kinds of grinding, it is the limit of the grain of the grinding wheel, the wall of the piece being ground and the accuracy demanded by the maker of the pieces to be ground.

QUESTION:—Do you see any fundamental obstacle to the general use of ball bearings for carrying the main spindles of grinding machines?

MR. KNIGHT:—Yes.

CHAIRMAN YOUNGER:—Is there any objection also to the general use of roller bearings for such purposes?

MR. KNIGHT:—I have seen experiments carried through for the use of ball and roller bearings for the wheel spindle, and I would never expect them to be used for precision grinding. The bearing surface is not sufficient to withstand the present out-of-balance wheels. Chatter-marks constitute the greatest trouble we have in grinding. Almost always, on precision work, when ball or roller bearings have been put into the wheel spindle as a bearing, chatter and mottle troubles have been increased. The smooth bronze or babbitt-lined bearing with a force-feed oiling system is the best bearing for wheel-spindle construction. For internal work, a number of very successful ball-bearings are used because of the high speed, but the speed of the small wheel for internal grinding does not affect the little inaccuracies of the balls of the ball bearings. The cutting particles in that small wheel run so fast that they pass over or split into many times the number of chatters that would occur if they were made in a cylindrical machine or precision-cylindrical machine wheel-spindle bearing.

CHAIRMAN YOUNGER:—You said that you took the gears out of the machine and substituted a silent chain. Were those gears of cast-iron?

MR. KNIGHT:—One member was hardened steel and the other cast-iron. The trouble with the gears is not that they are *gears* but is attributable to the difficulty of making *good gears*. Only by the use of gears could we secure power and production until we used the chain. Engineers who formerly were afraid to use chains seem not to be afraid to use them now. We find that they are very successful in many different types of machine-tool, especially where the machine-tool is used for precision work. The chain or soft belt has eliminated our troubles when we have found a poor quality of gears in any particular machine.

QUESTION:—Can the reciprocating-wheel device be installed on standard-make grinding-machines now in production?

MR. KNIGHT:—The device mentioned in the paper can be applied to any machine made by that concern.

QUFSTION:—What developments have been made in grinding ring-grooves in pistons?

MR. KNIGHT:—I know of no production developments.

QUESTION:—Why is wide-wheel grinding limited to 9¾ in.?

MR. KNIGHT:—That is as far as we have had experience. The wheel-makers say that no limit exists as regards the making of the wheel but, the farther away we get, the longer or larger are the spindles that are needed to withstand the pressure on the end of the spindle. To put a bearing on the outside of a wheel or on the inside of a wide-face wheel is not good practice, because, when the wheel is changed, that bearing must be removed and then the alignment eventually will be lost between the bearings supporting the wheel.

CHAIRMAN YOUNGER:—What is the maximum width of face used?

MR. KNIGHT:—It is 10 in.

QUESTION:—No mention has been made of the hydraulic traverse. What is your opinion regarding this?

MR. KNIGHT:—It is not very old as yet. It is working out very nicely on internal machines but in the case of cylindrical grinding, where so much water and so

much lubricant are present and so much necessity exists for protection against the grinding material that is removed from the pieces and the splash of the lubricant for keeping the work at even temperature, not very many grinding-machine builders have gone into that method of drive for precision-work.

QUESTION:—Have you used the wheel-reciprocating device in grinding cams?

MR. KNIGHT:—No, except in an experimental way.

QUESTION:—To what extent has the diamond been replaced by other truing devices?

MR. KNIGHT:—In automobile plants, about two-thirds of the grinding machines are now using mechanical devices for truing wheels, and they are very satisfactory for both roughing and finishing.

ARTHUR C. PLETZ[2]:—I do not wish to contradict Mr. Knight's statement by saying that the lead-lapping process is not the best thing to use, but I believe that we have not developed a process in lead-lapping that would be practical on crankshafts. We build crankshaft-polishing machines and we use the felt wheel for polishing. I agree that, if there is a slight out-of-round effect, it will be maintained; but I think it is the best commercial proposition obtainable. The departments in which I have been recently that polish crankshafts have always used the hand method. We believe it is not the best method; it is difficult to get men to handle the "lemon-squeezer" type of polisher. It is wearing on the men's arms and does not produce the best finish. I believe that we get the production on our machines; in fact, we can better the production in most cases. In a plant where they turn out from 600 to 700 crankshafts per day, I was asked: "What is your production on the crankshafts?" I answered: "Sixty, probably 70, crankshafts per hr. with three machines." I was told that they had three high-speed lathes, or three speed-lathes, and that they maintained this production. I was shown some of their crankshafts and believe they were not improving them very much by their method. Our machine would maintain that same production and give them a decidedly better finish. In some cases in which a very high-grade finish is wanted, probably our production would not be as high as that of the lemon-squeezer type of polisher, or the hand-method, but I know it would be decidedly better and give a longer life to the crankshaft bearings.

Our machine is very much like the grinding machine. We use very hard felt and dress it with a certain preparation. For instance, on a four-cylinder crankshaft we will have one machine set-up with three wheels to handle the three main bearings; the other machines will have two wheels and will handle the pin bearings. The operator puts the work in between centers on his main bearings or into his pot-chucks for his pin bearings. The wheel is the full width of the bearing; he brings it right up to the work, holds it there for a few seconds, brings it back and takes out the crankshaft.

MR. KNIGHT:—What is the purpose of that buffing operation?

MR. PLETZ:—Microscopic photographs taken of the crankshafts show that we get a much higher finish and a much smoother surface; this means a longer life for the bearing.

MR. KNIGHT:—This is because the grinding operation was a poor one. You ought to improve the grinding operation.

MR. PLETZ:—We are improving the grinding finish.

MR. KNIGHT:—You follow the shape of the piece, whether it is round or straight or tapered and, while you do improve the quality of the finish, you take away the ground finish that was put on it with the grinding machine, do you not?

MR. PLETZ:—Yes.

MR. KNIGHT:—That proves that the operation of grinding has been a poor one.

MR. PLETZ:—I find that internal-combustion engine-builders polish the bearings after they are ground in practically every plant. They change the ground surface because this is necessary. I believe there is not a crankshaft that goes into an engine that is not polished after it is ground.

MR. KNIGHT:—That is true.

W. D. BLISS:—A grinding-machine company always asks what degree of finish is wanted. Mr. Knight spoke of the degree of finish desired and its relation to production. I have never been able to get any set of standards that would determine the finish desired. If any such thing as a standard degree of finish exists, how do you tell another man what degree of finish you want?

MR. KNIGHT:—One company has been striving for many years to classify the standards of finish into rough, commercial, reflective and highly reflective. One can read a newspaper held up against the reflective finish; it is one that will reflect what is held against it. When we are requested to make a finish, we know that we have to make it to suit that customer; sometimes we think it is poor and he thinks it is good, but we suit him. We get more production with a commercial finish than we do with a reflective or a highly reflective finish. More time is required to turn out a quality job. The average work that we do is the commercial finish, of course. All the factories are getting into the quality work. Everyone wants the finest grade of finish and the greatest accuracy. Machine-tool companies are building apparatus to produce that fine quality as rapidly as the commercial finish and commercial-limit work.

C. F. WASSERFALLEN:—We made a separate operation on finish. We never touched the bearing, regardless of the speed at which it was running, even at 3600 r.p.m., and we made two operations. In fact, it was the first commercial grinding done in this Country. We roughed it and then we finished it; we made good speed and we never touched the bearings. We had three finishes: rough, commercial and mirror. We asked for mirror finish and we got it; it was better than any lapping job. Defects could not be detected by measurement. I believe lapping or buffing is not necessary. I believe it is not as cheap as putting the work through a second operation with a small amount of grinding; and the latter is positive.

W. G. CAREINS:—Mr. Knight said that his company had made experiments with the oscillating attachment on cam grinding. What were the results?

MR. KNIGHT:—They are very interesting. I believe we will recommend it for this class of work. Grain-lines are produced in cam grinding just as they have been in every other kind of grinding; the hand movement of the table-drive apron handwheel has always been necessary in cam grinding to break up the grain-lines. Cam and camshaft grinding have been the most difficult work we have had to handle. Accuracy is and always has been wanted on cams, and more so now than ever before. If we can break-up the grain-lines and make the finish of the same quality as though made by a traversing operation, instead of a straight-in operation, that is the purpose of the oscillating device, the reciprocating-spindle attachment. It will be attached for cam grinding

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as well as for every other kind. It also will be used for shoulder grinding on semi-automatic and automatic machines. Where it is desirable to dwell a little longer in the shoulder, the cam in the device will be made in such a way as to cause this dwell period the same as though the wheel were traversing, and the reversing mechanism will let the wheel dwell there a moment to grind out the V.

MR. CAREINS:—Some of the speakers are confusing lapping and polishing. I have always considered them to be two entirely different operations.

JOHN A. C. WARNER:—With reference to the finishing of piston-ring grooves, the Society has made an investigation of the processes that are being used by the various manufacturers. It has been found that very few are using a grinding operation. Most of them are doing the finishing by using burnishing tools, such as a burnishing disc. The results of the investigations are to be published in an early issue of THE JOURNAL.

H. P. HARRISON:—Is there any general trend toward rough-grinding crankshafts as compared with rough-turning?

MR. KNIGHT:—The rough-grinding of a crankshaft pin was begun about 1909, when the forged crankshafts were brought-out with all pins forged in shape. Then, the most successful method of grinding crankshafts was to grind from the black stock or forging, in what we called a rough-grinding operation, and to pass to a second machine for the finish-grinding operation. The cost of grinding wheels increased, the keeping-up of dies was found to be expensive and, to make it expedient to grind crankshafts from the black stock or the forging, ¼-in. of stock must be maintained. By the turning method, when larger production turning-lathes were developed, manufacturers could neglect the stock-allowance in the up-keep of their dies and, because of the expensive wheels, it became practically impossible to compete by rough-grinding from the black stock. The trend will not be toward rough-grinding of crankpins from the black stock until better results shall have been obtained from our experiments or more knowledge secured in regard to the automatic-wheel in-feed grinding of crankshafts referred to in the paper. When that time comes, perhaps we can talk more about the re-establishment of the rough-grinding from the black stock. The way to grind crankshafts is to rough-turn them first, leaving from 0.030 to 0.045 in. of stock, and then to make a rough-grinding operation and a finish-grinding operation, which decreases the excessive cost due to expensive wheels.

THE HUMAN ELEMENT IN PRODUCTION

BY W. F. JAMESON

PRODUCTION is largely dependent on the human element, which is called by different terms according to the degree of intelligence expected from persons of different ranks; varying from ordinary stupidity among those of low intelligence to the "errors of judgment" of those higher up, it has been defined as a "temporary lack of application of one's attention to the thing at hand," and its effect on workmen of various temperaments is to lower production. Concentration is shown to be the central truth and the cause of one man's superiority to another. When supplied with an incentive, such as that of feeling that he is working for himself, a workman will concentrate his attention on his work with profit both to himself and to his employer. But apparently insignificant things preying on his mind will often cause a lack of concentration. Education is an endless process of growth and accomplishment. The motive back of the desire for a college education is the gathering of a fund of knowledge and experience that will enable one to cope better with the problems of life. A going manufacturing company offers real problems for solution and obstacles to be overcome. Every job can be made a training school of experience if the holder will make it so; the production game furnishes everything necessary for growth. Inertia is the great obstacle, while autosuggestion, on the other hand, is of great assistance in instilling spirit into one's work. The determination continually to learn something new, to overcome all obstacles and to take advantage of opportunities that are presented will not only make the time pass quickly but will also increase efficiency.

THE DISCUSSION

PRESIDENT H. W. ALDEN:—A paper such as this is a good healthful thing for us to consider seriously. Most engineers, when they waste money, get their bumps from the management. Most factory organizations get their bumps when they fail to provide proper equipment for producing the work. So far we have focussed our attention in industry principally on designing things that can be produced economically and on the tools that can produce them economically. We have spent precious little time on the human end of it, and this is probably the biggest end. We are very apt to overlook the big bet in this life, right along. Undoubtedly, we have been overlooking it in the automobile field, the same as in other fields.

Recently, I was talking to the general manager of a fairly large steel company that has a well-managed plant about what effect the 8-hr. day would have on the cost of steel. He said that before answering the question he would wait and see the result of certain experiments that they had in progress. The experiments were in the nature of just the subject matter of this paper, the devoting of his time to the men and the conditions under which they worked, and giving the men a chance to show what men can really do. He said he had about reached the point where he could predict that, because of the changes in running his plant which he was putting into effect, the cost of steel per ton would go down when the 8-hr. day was in full swing, and would not go up. He might just as well have done that before, but the incentive did not present itself until he was faced with the 8-hr. day in place of the 12-hr. day. He is a pretty hard-headed man, and I thought it a good illustration of what can be done when we use our brains. I am inclined to think that most of us who manage men do not make use of as much brain-power as we could. The point on which Mr. Jameson touched particularly is one that I know from my experience. When the work comes out of a department wrong, when any labor trouble springs up or when things do not go just exactly right, the trouble is most apt to be with the foreman. As they say in the Army, if we have good top-sergeants in the regiment, we do not care what kind of a colonel we have.

QUESTION:—What method does Mr. Jameson use to reward the men who have shown evidence of concentration and of thinking out their own problems?

W. F. JAMESON:—The man pays himself his own reward. This comes in the satisfaction that he gets in

being loyal to himself; to that extent he pays himself his own dividend. He is working for his own interest.

PRESIDENT ALDEN:—Can you sell that idea to him?

MR. JAMESON:—Absolutely. This has been done time and time again. It is not a cure-all to be handed out on a silver platter for any and all classes of workmen. Some classes we cannot touch with it. To grasp it requires some intelligence. Some men have only the machine side to offer and nothing more; but, so far as we carry the proposition, we can sell them on the idea that the benefits accruing from it are well worth the effort put forth.

QUESTION:—Will you give one or more specific instances of securing the interest of the man?

MR. JAMESON:—Those who have tried the selling game know that the first step is to get the attention and then arouse interest and the like. I intimate in the paper that it requires pretty good salesmanship sometimes to put this over; but, in my experience, I have found it very easy to get the attention of almost any individual in a proposition similar to this, regardless of his station in life. I have tried it on various classes of men purposely to see how it takes root, to determine the kind of ground and how fertile the ground should be for the idea to take root and grow. You would be surprised to see how the men listen. All depends on the caliber of the individual as to the fruit borne.

QUESTION:—What are your recommendations for starting an idea of this nature in the average manufacturing plant?

MR. JAMESON:—I have stated that this idea cannot be applied to a group collectively, or in a wholesale manner. It is new and a little out of the ordinary; possibly it is just a little advanced for these times. But, in our respective connections with the organizations with which we are associated, most of us know that endless conflict which is going on in production today. There is an unrest; there are always the two extremes. As long as a workman shows a spirit of fight, you will never get anywhere; it is blow for blow. But, if you turn every man's attention inward on himself along the lines stated, he will work out his own salvation. A man might pick half a dozen men in his department who will listen and reason and understand the principle that is set forth in the paper, principally on account of their selfishness. That point is important; we cannot get away from the fact that every one of us is selfish; it is the selfish gain that every one of us is capitalizing in this business. The thought: What do I get out of this? prompts most human action. Teach this to say one individual in each department. The subtle influence that this man has on his fellow man, if he exhibits it in his work, cannot help but multiply. No line can be drawn as to how far one can reach with that much effort expended. Some people may consider these principles "Sunday-school ideas," as one man expressed it. If they are Sunday-school ideas, it is time to inject a few of them into production. But the conditions are not right for coming out with a definite positive program and sweeping it in. That cannot be done; there is too much indefiniteness in the human being, and in his response to any action you take toward him. Therefore, the only way to bring such things about is by the gradual process of leavening one measure of meal and letting it leaven the whole loaf.

PRESIDENT ALDEN:—A subject such as that which Mr. Jameson has presented is so intangible and so non-responsive to the slide-rule that it is a very difficult idea to get across successfully. Without doubt, if we knew how to do all these things we could speed-up production, lower costs, get the standard of living where it belongs and have things as they ought to be. I think this is about the only way it will be done. If we could get the laborer to use his brains, we might get out of the difficulties we are in; but you never can get that unless the man over him uses his brains. That is true all along the line.

THE APPLICATION OF CONVEYOR EQUIPMENT TO A SMALL PRODUCTION PLANT

BY H. P. HARRISON

TO install conveyors in a going automobile manufacturing plant of moderate size, without interrupting production, and with a minimum amount of rearrangement of the plant and an investment commensurate with the saving to be effected, was the problem, the solution of which is herein described. The conditions that determined whether power-driven or gravity-actuated conveyors should be used are discussed and the various types required for handling raw stock, for machining operations, for sub-assemblies and for finished assemblies are indicated. Among the operations for which conveyors were found particularly advantageous are those of handling cylinder castings from the storage of raw stock to the stockroom for finished parts; carrying cylinders between various machining operations and from the inspection bench to the storeroom for finished cylinders; machining transmission cases; carrying rear-axle gearcases through machining operations and delivering them to the starting end of the axle-assembling line; handling parts between departments and machines; assembling transmissions, engines, and front and rear axles; carrying axles to the washing and paint-spraying machines, thence to the chassis assembling line; handling the trimming of open bodies; the final conveying of chassis and finished cars; and handling the finished cars through the final-inspection and touch-up operations. The conclusion reached is that the use of conveyors not only pays, but pays well.

THE DISCUSSION

QUESTION:—How are the cylinder carriers returned?

H. P. HARRISON:—On the downward traveling side of the elevator chain. They are fed in at a point just below the delivery section, delivered at the basement level automatically and dropped into a pile at that point.

QUESTION:—Could the engine have been brought to the chassis at ceiling level, thus saving floor space?

MR. HARRISON:—Probably it could have been. The conveyor used for this purpose is a parallel installation of the final-car conveyor adapted to handling engines, which was installed originally for additional production of assembled cars. It is simply a duplicate of the belt conveyor on which the car is built and, not being required for that purpose, was equipped to handle engines.

QUESTION:—What will the 40-per cent saving in the cost of handling, which results from the conveyor system, mean in percentage of saving in the cost of the car?

MR. HARRISON:—The 40-per cent saving refers to the

final-assembly conveyor-line and would probably amount to a 2-per cent saving in the labor cost of the car.

QUESTION:—Are all conveyors moving continuously while the operations are performed?

MR. HARRISON:—Yes; they are driven by variable-speed motors that can be set for any desired amount of production and move at a predetermined rate throughout the day.

QUESTION:—Do you contemplate applying conveyors to carrying small finished pieces from machines?

MR. HARRISON:—We have not devoted much thought to that. One installation of this type that was tried was a failure because of our inability to keep men at the ends of the conveyor to load the work and take it off as the conveyor attachments passed. The time spent by a man remaining at those points continuously would be far greater than that required to truck the parts in stock boxes to the finished-stock room.

QUESTION:—Why were there so many conveyor failures in the older installations?

MR. HARRISON:—It seemed possible to move cylinder castings to an operator and take them away at a certain speed. The fact that we would not do that developed immediately; the control of machine breakdowns and matters of that nature defeated the idea of taking the work away from the man as fast as we desired. We find that the gravity installation does all that we wish the conveyor to do and, at the same time, it provides some allowance for such things as breakdowns and other production delays.

QUESTION:—How are the cylinders cleaned?

MR. HARRISON:—They are sand-blasted, inside and out, at the foundry. When received the cylinders are cleaned at the end of the machining line in a kettle provided with a steam coil for heating and with steam jets for atomizing and spraying steam and hot water into the valve-ports and the cylinders. This operation supplies enough heat to the cylinder casting to dry it, after which it receives a coat of paint.

QUESTION:—Is there an auxiliary method of moving parts in the event of a conveyor unit breaking-down?

MR. HARRISON:—None, except resorting to the old method of using hand-trucks. This, of course, requires emergency men and methods, but we have had no breakdowns of conveyors that delayed us more than 1 or 2 hr. We operate only 8.7 hr. per day and, ordinarily, are able to remedy any breakdowns in the interval between one day and the next. Very little hand-moving has been required in the year that we have had the installations in operation.

QUESTION:—Do you weld or plug blow-holes in the cylinder walls?

MR. HARRISON:—When the hole does not go entirely through the cylinder wall we use the common method of welding with nickel wire and peening the resulting weld into a smooth surface before finish-grinding. We have used this method with good results for about 5 years. When the water-pressure test shows that such a defect passes entirely through a casting, the casting is discarded immediately.

WAGE-INCENTIVE SYSTEMS

BY EUGENE BOUTON

NUMEROUS wage-incentive plans are now in operation in the various automotive and other industrial plants; but the proper system to install in a given plant, whereby unit costs will be maintained level and at the same time proper cooperation from employes will be obtained, has always been open to discussion.

One plan now in use by the company represented by the author is straight individual piece-work on small-parts operation where one, two or even three operations complete the particular part, and where only one or two operators are engaged in machining or assembling the particular unit; whereas, on the major machining and assembly units such as cylinder-block machining and engine or complete-car-assembly units group piece-work is employed throughout the entire plant.

By the installation of individual and of group piece-work, unit costs are maintained level at all times; in addition, the workmen employed are able to determine very easily by their own calculations what they have earned either daily or at any hour of the day. This is in direct contrast to other and more complicated systems wherein unit costs are not maintained level over given periods and workmen in many cases are required to work for a complete pay-period without being able to ascertain their earnings over and above their guaranteed day-rates.

Still another feature of the group and the individual piece-work plan is the small clerical force necessary for the functioning of the system. The company and its employes feel that the wage-incentive plans now in operation have met all of the principal objections generally experienced with other wage-incentive systems.

THE DISCUSSION

EUGENE BOUTON:—Supplementing my paper, Fig. 1 shows the day-work authorization-card. Whenever there is a breakdown in equipment, lack of materials or the like, and it is necessary to make an allowance to the group for delays, this form must be filled out by the department foreman and approved by the production manager and the time-study department before the amount due can be paid. We have found that this method controls the amount of day-work allowances, so that no day-work will be paid for unless the group is entitled to it.

PRESIDENT H. W. ALDEN:—What effect has a group plan had on labor turnover?

MR. BOUTON:—It has reduced the labor turnover in our plant.

PRESIDENT ALDEN:—Has the labor turnover been eliminated?

MR. BOUTON:—Not entirely. A certain percentage of labor turnover is a good thing for any plant. In individual piece-work, or in individual effort applied to jobs where a group would do much better, we find a closer cooperation among the employes. The men try to help one another. The attendance is much better.

QUESTION:—Under your plan, an increase in a man's rate is paid out of subtractions from his fellow-workmen's compensation. How do they accept that?

MR. BOUTON:—If certain members in a group apply themselves and are on operations that require exceptional skill, they should receive a greater reward than the new men entering the group, or unskilled men. They merely receive a higher pro-rated share of the earnings of the group. It is up to each man to improve himself as much as possible. However, a limit exists as to how far a man can go. The management has specified the high limit; when a man reaches it, he can go no farther so far as getting a higher rate is concerned.

Often, when one man is shiftless and does not want to work, the men run him out. However, no matter what his personality may be, if he is a good worker in the group, seldom, if ever, is a man run out of the group.

QUESTION:—How are the men in each group informed of their earnings each day?

MR. BOUTON:—The foreman gets a copy of the group piece-work report and, if the men care to know what their earnings are for the preceding day, he can tell them. After the group has been in operation for some time and it produces say 50 to 60 units per day, the men can gage what their earnings are very readily.

QUESTION:—If an inexperienced employe is behind in his work, how long do you carry him at the day rate?

MR. BOUTON:—Generally, 2 days are allowed for a new employe to become accustomed to the operation to which he is assigned. It is to the interest of the remainder of the group to assist that employe to learn his operation as quickly as possible. If he cannot come up to the speed that is required, he must be taken out of the group.

QUESTION:—In a group of five men, how are you sure that the best man gets the most pay.

MR. BOUTON:—A time-study man assists the foreman in determining which men are the most skilled or what the heavy operations are. In rating the men considerable good judgment must be used.

QUESTION:—If an operator is transferred to a lower piece-price job, how do you adjust his pay, provided he is efficient on the transferred job?

MR. BOUTON:—The lower piece-price work on another job would require less men in the group. The man's earnings would not be affected.

QUESTION:—What do you consider a fair percentage to add for fatigue and contingency to the actual time-study schedule?

MR. BOUTON:—That depends upon the nature of the job. Some jobs are fast and require great accuracy. Some companies allow 10 and some 20 per cent. The machine-tool builders generally make estimates on a 20-per cent basis. The percentage depends on the job.

QUESTION:—What is done if a piece-price is set too high?

MR. BOUTON:—We do not cut prices because the earnings of the men are too high. The only way a price can be cut is through a change in the set-up where tooling is involved, or a change from one machine to a different type of machine. If the workman makes considerably more than was generally allowed, we must put up with it.

QUESTION:—What do you consider fair pay per day on a piece-work basis?

MR. BOUTON:—The standard of wages is fixed by the management and the base rates from which the prices are set are determined in that way. Each city has its standard of wages and each workman should earn the standard wage paid in whatever locality he is employed.

QUESTION:—What is the average scrap-allowance?

MR. BOUTON:—On some jobs it is possible to continue for some length of time without getting any scrap; other jobs are so precise or complex that perhaps 2 per cent would be a fair allowance for scrap.

QUESTION:—Do you charge the group for only the labor on a spoiled article or for the material also?

MR. BOUTON:—When a deduction is made from the group for the scrap, only the labor and time expended on the job are deducted.

QUESTION:—Does this system guarantee a minimum pay?

MR. BOUTON:—It guarantees the minimum hourly day-rate. However, if the operator can make only his minimum hourly-rate, we cannot afford to tie-up a machine with him and keep him indefinitely. He must make the base rate or the number of pieces specified on the route sheet to be satisfactory on the job. One reason the hourly production is shown on the route sheet is that the operator is expected to produce that many pieces.

QUESTION:—How long have you had this system in operation?

MR. BOUTON:—Approximately 6 months.

QUESTION:—When working on straight piece-work, should the rate be cut when a man's earnings, due to increased output, achieve the hourly rate of other men of the same grade?

MR. BOUTON:—No, it should not; if the operator becomes skilled and fast enough to make that amount of money, he is entitled to it.

DAY WORK AUTHORIZATION

Dept ..... Date .....

Name of Part | Part No. | Group No.

Description of Work

Reason for Day Work

PAY Piece Work / Day Rate at per | Requested by

Time Study Dept | Approved

FIG. 1—THE DAY-WORK AUTHORIZATION-CARD THAT MUST BE FILLED OUT BY THE DEPARTMENT FOREMEN WHENEVER BREAKDOWNS IN EQUIPMENT, LACK OF MATERIAL OR A SIMILAR OCCURRENCE NECESSITATES MAKING AN ALLOWANCE TO A GROUP FOR DELAYS

QUESTION:—Has the plan increased the inspection expense? If so, how was this taken care of?

MR. BOUTON:—The inspection part of the work has been decreased to some extent because we pay on the basis of accepted finished units. If any deductions are made, the men know that these come out of the entire group; therefore, if an operator tends to produce too much scrap, the other members in the group show him where he is making his errors or assist him to produce good work. I believe that in any group system, whether it is group-bonus or group piece-work, the amount of inspection is reduced.

QUESTION:—What average percentage of scrap is allowed?

MR. BOUTON:—Approximately 1 per cent average on machining operations.

QUESTION:—What percentage of your direct labor is piece-work?

MR. BOUTON:—Perhaps 90 per cent.

QUESTION:—What percentage above the day-rate does the average operator make on piece-work?

MR. BOUTON:—Painters and trimmers make considerably more than the day-rate. In the assembly department, it runs anywhere from 15 to 25 per cent over the day-rate. If 50 men are engaged in a group and one man is raised 50 cents per day, that reduces the earnings of the other members of the group approximately 1 cent per day. The revision of rates of one or two members from time to time does not change much the

earnings of the other members of the group. However, such changes are justified for the reason that the members who are raised are performing operations that require skill or are fatiguing. Revision of rates after the price is set seldom occurs because, when the price is set, all hourly day-rates are adjusted likewise to suit the classification of the various operations.

QUESTION:—Do you have to sell that idea to the group first?

MR. BOUTON:—No; we have never experienced any trouble along that line in adjusting rates within the group.

QUESTION:—What procedure do you follow in the group plan where, for instance, there are four men, and the man performing the last operation does poor work that necessitates the scrapping of the entire unit? Do you deduct from the pay of whole group?

MR. BOUTON:—Absolutely; inasmuch as the earnings of the group constitute collective effort, what one man scraps must be handled from the group standpoint.

QUESTION:—What deductions are made for tardiness?

MR. BOUTON:—If a man comes in 1 hr. late, he loses 1 hr. of his pro-rated earnings, but that is given to the other members in the group. The company does not receive any direct benefit from it, but some means of penalizing the man for non-attendance must be provided.

QUESTION:—Are speed experts placed in the group to increase production?

MR. BOUTON:—The regular operators assigned to a group are generally used. We do not resort to utility men or speed experts to set prices or to speed-up a group, unless the time-study observer recommends that other men be assigned to the group to obtain better production.

QUESTION:—Do you find cases of earnings running higher than was expected?

MR. BOUTON:—Sometimes, due to the group application of effort and cutting a few corners here and there, earnings have run slightly higher than the amount anticipated. That is common to all wage-incentive systems. It is expected that the group will produce as much work as possible, and some very clever time-saving methods are applied.

QUESTION:—Do you use the group system on inspection work?

MR. BOUTON:—In general, inspection is day-work. There is practically no piece-work on inspection operations.

QUESTION:—What provision is made for an absentee from a group?

MR. BOUTON:—None. If there are 10 men assigned regularly to the group and only 9 show up, they continue to produce the unit and their earnings are pro-rated among the 9 men. If several operators are absent, it would be necessary to add other men to the group.

QUESTION:—Does the group plan affect promotion?

MR. BOUTON:—Promotion is handled in the same manner as under any other system.

QUESTION:—How is the tool department paid?

MR. BOUTON:—On the day-work basis.

QUESTION:—Do the men have any voice in the selecting or hiring of the men to work in their respective groups?

MR. BOUTON:—If a man should be assigned to a group and, for some particular reason, the group objected to his being placed in that group, the men would take the matter up with the department foreman. If they had reasonable objections, the man would be assigned to other work and some other man would be substituted.

QUESTION:—What constitutes a unit?

MR. BOUTON:—Any part that can be machined by consecutive operations, or any number of small parts that can be assembled into one major part, is called a unit; for example, all machining operations on a front axle, the assembly of a complete engine, all the machining operations on a crankcase, or the assembly of a complete transmission.

QUESTION:—Do you find that the individual effort is destroyed in a group of 90 men?

MR. BOUTON:—The individual effort is practically the same in a large group as it is on straight piece-work. The men are all anxious to help one another. Whenever congestion occurs in one part of a group, the other men assist without any orders from the foreman.

QUESTION:—Are the guaranteed hourly-rates equal to or lower than the going rates for straight day-work?

MR. BOUTON:—They are lower than for straight day-work. If we have a day-work operation, the day-rate for the operator is naturally a little higher than it would be for an operator whose operation is piece-work.

QUESTION:—What operations can be grouped best?

MR. BOUTON:—That must be determined largely by the individual plant. Assembly work lends itself very readily to group piece-work; also many machine operations. For some small parts requiring only one or two operations, we have found straight piece-work better than group work. Some plants place in a group 8 or 10 machines that are working on entirely different parts. We have never done that; only the job itself carries the piece-work price.

QUESTION:—Is not a community of interest established by the group that has a tendency to unionize a shop?

MR. BOUTON:—That question has been brought up many times. We have not had a single argument with any group that has not been adjusted satisfactorily. The groups have never made any unreasonable demands upon the company since the plan has been in operation. We believe that our freedom from the difficulties indicated is due largely to the piece-work feature of the plan.

QUESTION:—Does your group system at any time take care of a labor shortage? How do the men react then?

MR. BOUTON:—The group workers' interest in their work has been the means of getting good labor into the group. Each individual group-worker may know of some man he would like to have in his group. Men have even gone to the employment department and asked permission to bring in such a man, knowing that we were short of labor on some operations. The system has been much better for the company than the straight piece-work system was.

QUESTION:—It is very seldom that we can expect 100-per cent quality. Do you provide a motive for producing quality?

MR. BOUTON:—No reward is given for quality other than the rate, with the penalty for scrap provided for.

QUESTION:—How do you prevent a foreman from showing favoritism to some friend or individual in a group?

MR. BOUTON:—We have not experienced much difficulty along that line. The matter is watched carefully. All rate-increases that go into effect pass through the hands of the production manager and others. If any evidence of favoritism were shown, either in the assignment of men to operations or about the rates, it would be observed very quickly by other members of the group and called to the attention of the production manager and the time-study department.

QUESTION:—How do you determine who is at fault

when deduction for scrap has to be made from the earnings of the group?

MR. BOUTON:—When the piece is inspected and the cause of the scrap is determined, we can trace it back directly to the man who performed the operation. The group then knows who is responsible. The men take the subject up with this member of the group and help him to improve his work or have another man put in his place.

PRESIDENT ALDEN:—Have you found this group plan effective in weeding out undesirables?

MR. BOUTON:—It has been very effective. Men who did not show very much activity or were careless and indifferent on the jobs were eliminated by the group itself.

PRESIDENT ALDEN:—That has been the experience of a corporation of which I know, wherever the management installed the group plan.

J. C. W. SMITH:—The Willys-Overland Co. has used straight piece-work for about 3 years. The prices are set from time studies. We follow out the principles Mr. Bouton has outlined except that, where it is necessary to work the men in a group, we divide the money between the men in the group according to the hours they work. The group operations are divided so that the skilled man earns his money by his skill and the less skilled operators earn their money by the exertions they put forth. Individual piece-prices are paid wherever practicable; group piece-prices are paid when necessary. We have straight piece-work in place of standard time, because we believe piece-work is direct, simple and easily understood. The men know that they will receive so much money for doing the operation each time it is performed. The defect in standard time, as we see it, is that, for the man to know how much money he will receive on pay-day, he must divide his actual time into the allowed time, which gives him his percentage of efficiency. By referring to the bonus table, he finds out what percentage of bonus he is paid for his efficiency and, by multiplying his day's wages by the percentage indicated in the bonus table, he arrives at the amount of money he will receive in addition to his day-work earnings. If two men working at a different day-rate on identical operations finish the same number of pieces in the same time, they will receive a different amount under standard time. Our company guarantees its approved piece-prices for the calendar year. We believe that 25 per cent of the increase in the efficiency in our plant in the last 2 years was due to the fact that the men knew and understood the guaranteed piece-price and realized that they would not be penalized for the efficiency they developed. Guaranteed prices are designated by letter prefixes on the piece-price schedule. For example, in X189, the X indicates that if a change in the operation is made, the change in the price will be in exact proportion to the time that it takes longer or less to do the operation, for the year 1923.

MR. BOUTON:—Mr. Smith's principal objection to the standard-time system is typical of many other systems. For example, if two operators were engaged on the same job and their hourly-rates were 60 and 65 cents respectively, and both operators finished the same number of pieces per day, the 65-cent operator's earnings would be more than those of the operator with the 60-cent rate; therefore, it is not equal reward for equal effort and, in addition, the cost department has a variation in cost and it is this cost that must be accumulated over a period of time to arrive at an average cost. Where several operations are necessary to complete one unit, it is not always possible to balance the operations so that each can be performed in the same length of time. Assuming that the first operation required 10 min., the second 8 min. and the third 6 min., it can be seen readily that the production of the 6-min. operation would be no more than that of the 10-min. operation; therefore, the 6-min. operation operator assists the operator on the first operation so as to maintain a balance of finished pieces, and this is where the efforts of group work are applied which would be impossible with individual effort or straight piece-work. Progressive assembly or progressive machining operations are performed more economically with the application of group piece-work. If all operations were in perfect balance, it would be possible to use straight piece-work. However, there is seldom if ever a job of five or more operations wherein all operations balance; and it is not feasible, owing to the production of each operation, to maintain an operator for each. The group plan fixes the number of men to be assigned according to the schedule of finished units. As explained previously, all of the group operations are combined into one, a price is set thereon and all members of the group participate in the group earnings according to their hourly-rates and the number of hours worked.

QUESTION:—In leather cutting, do you pay an incentive wage for saving leather?

MR. BOUTON:—Yes. The amount of leather saved or the number of square feet cut out of the hide determines the operator's earnings.

THE STANDARDIZATION OF METHODS OF APPLYING THE SCLEROSCOPE

BY A. F. SHORE

A STATEMENT is made of nine items suggested by the Iron and Steel Division of the Society for consideration with reference to securing greater uniformity in practice when making precision hardness-tests with the scleroscope. Plumbness of the instrument is an important factor and lateral vibrations have a bad effect; these are discussed and surface smoothness of the test-specimen is considered in relation to its effect on accuracy.

Other factors treated are the influence of metal-scale on scleroscope readings, the condition of the hammer diamond, and the effect of the mass of the test-specimen. Extreme under-weight specimens, inert and over-weight masses, the effect of hardness on mass and the effect of thickness of the test-specimen receive consideration, together with points concerning testing near test-specimen edges, the effect of curved surfaces and how test-specimens are held. A lengthy comparison between Brinell and scleroscope hardness-testing is made. The paper presents photographs and illustrative charts.

THE DISCUSSION

QUESTION:—Why do you use a plumb-rod instead of a spirit-level? Would not the spirit-level arrangement be more reliable in the hands of the average operator?

A. F. SHORE:—We think the plumb-rod is better for

all-round service. Sometimes, when you are not looking, you can hear it rattle. That is a warning that the spirit-level would not give.

QUESTION:—Is it not the universal practice to polish test-specimens before they are scleroscoped?

MR. SHORE:—Nothing is gained by polishing the test-specimen with very fine emery-paper or by buffing. An emery paper or wheel or a file of medium grade is good enough for all purposes.

QUESTION:—What of air-operating devices for the scleroscope to prevent the cramping of the operator's hand, because of the large number of times he must open and close it?

MR. SHORE:—Such devices are in use, but we have not undertaken to manufacture them thus far as very little demand is made for them.

QUESTION:—Is it necessary to clamp parts, such as the wristpin, in the vise?

MR. SHORE:—No, if a slight allowance can be made for loss due to imperfect under-support and for hollowness.

QUESTION:—What is the best method of testing flat wire of 0.002 to 0.020-in. thickness?

MR. SHORE:—Clamp it flat on the scleroscope anvil with possibly a grooved guide, but it may be flat at the bottom.

QUESTION:—Does a change in the quality of the atmosphere cause any difference in scleroscope readings?

MR. SHORE:—We doubt if it does, unless actual moisture in the form of dew accumulates in the glass tube.

QUESTION:—What factor can be divided into the Brinell hardness reading to obtain the relative scleroscope reading?

MR. SHORE:—That is stated on a chart that we supply. No single factor can be used except at a particular range of the hardness scale.

QUESTION:—Do weather conditions affect the calibration of the Model-C scleroscope?

MR. SHORE:—It requires actual free-moisture, such as the formation of dew particles, in the glass tube.

QUESTION:—How can the hardness of two cylinder-blocks be determined when the scleroscope and the Brinell readings are approximately the same, yet one can be machined easily and the other is too hard to machine?

MR. SHORE:—If there is a difference in the resistance to machining, except possibly for a thin film of glass-hard scale, both methods will indicate such a condition in terms of hardness.

QUESTION:—In testing carbon blocks, of hardness ranging from 60 to 85, a difference of 10 to 15 per cent occurs between different instruments under identical conditions, although the same instruments give identical readings on steel test-blocks. Is there any explanation?

MR. SHORE:—For testing carbon, the penetration is often so deep that the diamond has to be fashioned especially for that purpose, with the sides of the cone frustrum also standardized.

FACTORS GOVERNING "OUT-OF-ROUNDNESS" MEASUREMENT

BY A. H. FRAUENTHAL

IT is stated that an out-of-round surface having an even number of high-spots requires a checking instrument that has opposed measuring points; and that, if the number of high-spots on the surface is uneven, an instrument having three-point contact, and one of the points of contact located on the center line between the other two, is necessary. Concerning the use of the three-point method, for close work, the angle between the three points of contact must be selected according to the number of high-spots.

Divisions of the subject include types of out-of-roundness and those peculiar to certain machines, the three-point measuring system, errors of the V-block method, use of the V-block for elliptical objects, other methods of checking elliptical forms and indicator-reading correction. Three items for instrument improvement are suggested to manufacturers.

THE DISCUSSION

QUESTION:—What limit of out-of-roundness is allowable for wristpins?

A. H. FRAUENTHAL:—It is generally conceded to be 0.0003 in. Some plants demand that wristpins be absolutely round, but they mean by "absolutely round" 0.0002 or 0.0003 in. as a limit for out-of-roundness. We use a limit of 0.0002 in. ourselves and we have not found that 0.0003 in. gives us very bad results. In the higher-priced cars they like to lap a wristpin and they claim they get it closer than 0.0002 in. but I do not honestly know whether we can detect any appreciable difference in the operation of the engine with either one or the other.

QUESTION:—Is not the slight out-of-roundness obtained by present production methods practically negligible in automobile work?

MR. FRAUENTHAL:—It probably is if the machine is always running just right and the type of machine is such that it does not produce much out-of-roundness. However, a centerless grinding-machine produces very accurate work, provided the operations previous to the last grinding or finish-grinding have been done very carefully, so that the amount of stock to be removed is very small. On the other hand, if you crowd a machine of that type, it will most certainly produce out-of-roundness regardless of how tight all the moving parts of the machine are, the good care taken of it generally and the care given it by the operator.

QUESTION:—What amount of out-of-roundness have you found existing in crankshafts and in wristpins that has escaped detection?

MR. FRAUENTHAL:—I believe that no out-of-roundness on crankshafts has escaped us except that beyond the limits of the use of the micrometer. A good inspector can detect out-of-roundness of 0.0001 in. without very much trouble. Any amount of out-of-roundness might escape attention on a wristpin ground on a centerless grinding-machine if a three-point measuring-method is not used.

QUESTION:—Which do you find best for accuracy, the centerless grinding-machine or one that has centers?

MR. FRAUENTHAL:—We found that equally accurate work can be done on both types of machine. For some work, no doubt, the centerless grinding-machine is considerably more rapid than the usual type that employs centers. However, the centerless machine seems to give us somewhat more trouble, probably due to the fact that the operations preceding the last grinding are not done as carefully as is required for this type of machine.

The Packard Single-Eight

By J. G. VINCENT[1] *assisted by* W. R. GRISWOLD[2]

CLEVELAND SECTION PAPER *Illustrated with* DRAWINGS

LIMITATIONS regarding space available prevented the publication in the October, 1923, issue of THE JOURNAL of the mathematical analyses referred to in the paper on The Packard Single-Eight. These were presented by the author in two appendices, which are printed herewith.

ABSTRACT

STATING the fundamental characteristics of the modern motor car under the headings of performance, safety, economy, comfort and taste, the author defines these terms and discusses each basic group. The specifications of the car in which the single-eight engine is installed are given, and the reasons governing the decision to use an eight-cylinder-in-line engine are enumerated.

Following a somewhat lengthy discussion of the components of engine performance, the design of the engine is given detailed consideration under its divisions of crankshaft design and the methods employed, gas distribution, the operation of the fuelizer, cylinders, valve gear and the arrangement of the accessories. Transmission design and the wearing quality of gears receive similar treatment.

Brakes and steering are subjects that are treated at some length, arguments being presented in favor of four-wheel brakes and reasons given for their adoption, together with a discussion of their effect on steering ability and of the mechanics of brake construction. Comfortable steering, axle construction, steering-gear efficiency and axle noise are other subjects that are considered in detail. The paper is illustrated profusely and pertinent tabular data are included.

APPENDIX 1

ENGINE BALANCE[3]

On account of the acceleration of the reciprocating and rotating parts of the engine, dynamic forces are set up which, when unbalanced, produce either periodic displacement or simply vibration of the engine. A body of mass m acted on by a force F will have imparted to it an acceleration a and the relation can be expressed by

$$F = ma \tag{4}$$

If the weight of the body is W pounds, the mass will be

$$m = W/g \tag{5}$$

in which g equals the acceleration due to gravity, or 32.2 ft. per sec. per sec. Therefore, equation (4) becomes

$$F = (W/g)a \tag{6}$$

To find the acceleration of the piston, it is necessary to determine the piston travel and its velocity in terms of the angular motion of the crankshaft.

Piston Travel.—Referring to Fig. 28, we have, for piston travel in terms of the crank angle,

$$S = L + R - (R\cos\Theta + L\cos\phi) \tag{7}$$

$$= L + R - R\cos\Theta - L\,(1 - n^2\sin^2\Theta)^{\frac{1}{2}} \tag{8}$$

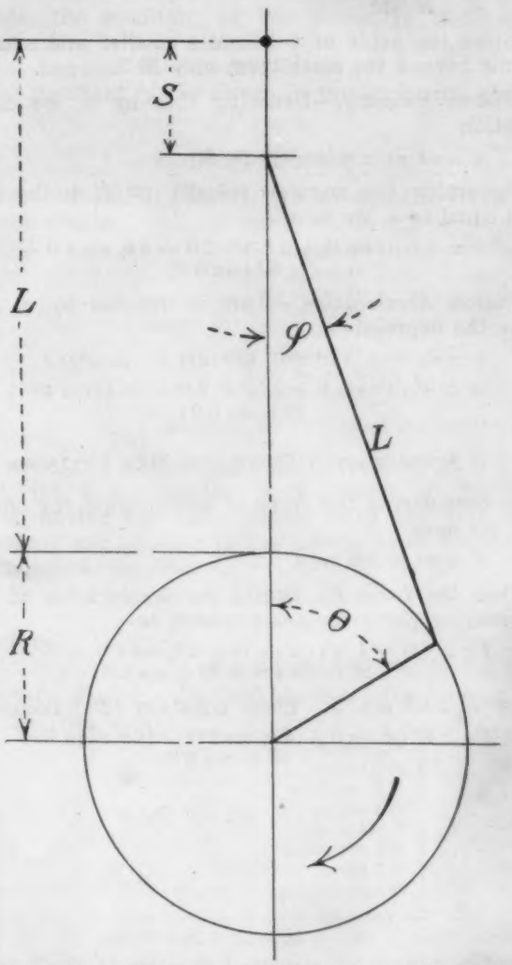


FIG. 28 — DIAGRAM OF THE RELATION OF PISTON TRAVEL, VELOCITY AND ACCELERATION IN A SIMPLE ENGINE

$$= L\,[1 + n - n\cos\Theta - (1 - n^2\sin^2\Theta)^{\frac{1}{2}}] \tag{9}$$

$$= L\,[1 + n - n\cos\Theta - (1 - \tfrac{n^2}{2}\sin^2\Theta - \tfrac{n^4}{8}\sin^4\Theta - \tfrac{n^6}{16}\sin^6\Theta \ldots \text{etc.})] \tag{10}$$

where

Θ = the crank angle
ϕ = the connecting-rod angle
S = the piston travel in terms of the crank angle in feet.
L = the length of the connecting-rod in feet
R = the length of the crank, or "throw" in feet
n = the ratio of the crank and connecting-rod (R/L)

But

$$\sin^2\Theta = \frac{1 - \cos 2\Theta}{2} \tag{11}$$

$$\sin^4\Theta = \frac{3}{8} - \frac{1}{2}\cos 2\Theta + \frac{1}{8}\cos 4\Theta \tag{12}$$

$$\sin^6\Theta = \frac{5}{16} - \frac{15}{32}\cos 2\Theta + \frac{3}{16}\cos 4\Theta - \frac{1}{32}\cos 6\Theta \tag{13}$$

[1] M.S.A.E.—Vice-President of engineering, Packard Motor Car Co., Detroit.

[2] M.S.A.E.—Engineer in charge of analysis of design, Packard Motor Car Co., Detroit.

[3] Figs. 1 to 27 and Equations (1) to (3) appear in the paper, as printed in the October, 1923, issue of THE JOURNAL, p. 257.

Substituting in equation (10) and reducing

$$S = L\,[k_1 - n\cos\Theta - k_2\cos 2\Theta + k_4\cos 4\Theta - k_6\cos 6\Theta + \ldots\ldots + k_n\cos n\Theta] \quad (14)$$

where

$$n = R/L$$
$$k_1 = n + n^3/4 + 3n^5/64 + 5n^7/256$$
$$k_2 = n^2/4 + n^4/16 + 15n^6/512$$
$$k_4 = n^4/64 + 3n^6/256$$
$$k_6 = n^6/512$$

Since the value of k becomes smaller and smaller, all terms beyond the sixth term may be dropped.

Piston Velocity.—Denoting this by v, we have the relation

$$v = ds/dt = (ds/d\Theta)\,(d\Theta/dt) \quad (15)$$

Assuming the angular velocity $d\Theta/dt$ to be uniform and equal to ω, we have

$$v = \omega L(n\sin\Theta + 2k_2\sin 2\Theta - 4k_4\sin 4\Theta + 6k_6\sin 6\Theta) \quad (16)$$

Piston Acceleration.—This is denoted by a, and we have the expressions

$$a = dv/dt = (dv/d\Theta)\;(d\Theta/dt) = (dv/d\Theta)\omega \quad (17)$$

$$a = \omega^2 L\,(n\cos\Theta + 4k_2\cos 2\Theta - 16k_4\cos 4\Theta + 36k_6\cos 6\Theta) \quad (18)$$

Acceleration Force for One Cylinder

In considering the force of acceleration for one cylinder, we have

$$F = ma = (W/g)a \quad (19)$$

Then the force F_a, due to the acceleration of the reciprocating parts for one cylinder, is

$$F_a = (W\omega^2 L/g)\,(n\cos\Theta + 4k_2\cos 2\Theta - 16k_4\cos 4\Theta + 36k_6\cos 6\Theta) \quad (20)$$

Let $K = W\omega^2 L/g$. Then, equation (20) becomes

$$F_a = K\,(n\cos\Theta + 4k_2\cos 2\Theta - 16k_4\cos 4\Theta + 36k_6\cos 6\Theta) \quad (21)$$

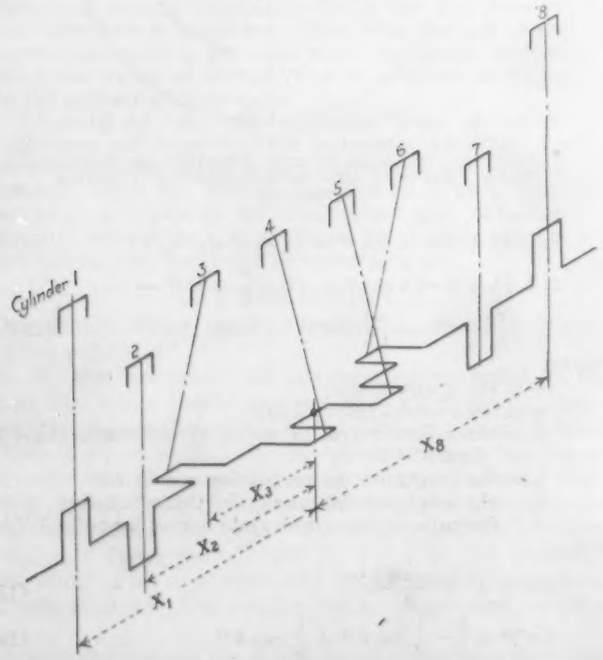


Fig. 29—General Arrangement of the Pistons and Crankshaft Throws in the Straight Eight-Cylinder Engine

The General Case of Engine Balance for Multi-Cylinder Engines

For an engine having any arrangement of the cylinders and crank-throws, the summation of the horizontal and the vertical components, and the summation of the moments in the horizontal and the vertical planes, can be determined separately. If the cylinders make any angle β with the vertical plane, we have, for the summation of the horizontal, h, and vertical, v, forces

$$\Sigma F_{ah} = \Sigma[K(n\cos\Theta + 4k_2\cos 2\Theta - 16k_4\cos 4\Theta + 36k_6\cos 6\Theta)\;(\sin\beta)] \quad (22)$$

$$\Sigma F_{av} = \Sigma\,[K\,(n\cos\Theta + 4k_2\cos 2\Theta - 16k_4\cos 4\Theta + 36k_6\cos 6\Theta)\;(\cos\beta)] \quad (23)$$

If x denotes the distance along the axis of the crankshaft, as in Fig. 29, we have, for the summation of the moments, M, in the horizontal, h, and vertical, v, planes

$$\Sigma M_h = \Sigma[K(n\cos\Theta + 4k_2\cos 2\Theta - 16k_4\cos 4\Theta + 36k_6\cos 6\Theta)\;(\sin\beta)x] \quad (24)$$

$$\Sigma M_v = \Sigma[K(n\cos\Theta + 4k_2\cos 2\Theta - 16k_4\cos 4\Theta + 36k_6\cos 6\Theta)\;(\cos\beta)\;x] \quad (25)$$

For the condition of perfect balance ΣF_{ah}, ΣF_{av}, ΣM_h and ΣM_v must be equal to zero.

Balance of the Single-Eight Engine

In the Packard single-eight engine, the angle β that the cylinders make with the vertical plane is equal to zero; hence when $\beta = 0$, we have $\Sigma F_{ah} = 0$ and $\Sigma M_h = 0$. Since $\cos\Theta = 1$ and the reciprocating masses are equal, we have

$$\Sigma F_{av} = K[\Sigma(n\cos\Theta) + \Sigma\,(4k_2\cos 2\Theta) - \Sigma\,(16k_4\cos 4\Theta) + \Sigma\,(36k_6\cos 6\Theta)] \quad (26)$$

Let

$$\Sigma F_{a1} = \Sigma\,(n\cos\Theta)$$
$$\Sigma F_{a2} = \Sigma\,(n\cos 2\Theta)$$

and the like for the forces due to the acceleration of the reciprocating parts for cylinders Nos. 1 to 8, and let Θ_1, Θ_2 . . . . . Θ_8 denote the crank angle for cylinders Nos. 1 to 8 respectively. Then,

$$\Theta_1 = \Theta$$
$$\Theta_2 = \Theta_1 \pm 180 = \Theta \pm 180$$
$$\Theta_3 = \Theta_1 + 90 = \Theta + 90$$
$$\Theta_4 = \Theta_1 - 90 = \Theta - 90$$
$$\Theta_5 = \Theta_1 - 90 = \Theta - 90$$
$$\Theta_6 = \Theta_1 + 90 = \Theta + 90$$
$$\Theta_7 = \Theta_1 \pm 180 = \Theta \pm 180$$
$$\Theta_8 = \Theta_1 = \Theta$$

Then, the primary forces for these cylinders are

$$\Sigma F_{a1} = Kn\begin{bmatrix}\cos\Theta_1\\ \cos\Theta_2\\ \cos\Theta_3\\ \cos\Theta_4\\ \cos\Theta_5\\ \cos\Theta_6\\ \cos\Theta_7\\ \cos\Theta_8\end{bmatrix} = Kn\begin{bmatrix}\cos\Theta\\ \cos(\Theta\pm 180)\\ \cos(\Theta+90)\\ \cos(\Theta-90)\\ \cos(\Theta-90)\\ \cos(\Theta+90)\\ \cos(\Theta+180)\\ \cos\Theta\end{bmatrix} = Kn\begin{bmatrix}\cos\Theta\\ -\cos\Theta\\ -\sin\Theta\\ \sin\Theta\\ \sin\Theta\\ -\sin\Theta\\ -\cos\Theta\\ \cos\Theta\end{bmatrix} \quad (27)$$

Therefore

$$\Sigma F_{a1} = Kn\begin{bmatrix}2\cos\Theta - 2\cos\Theta\\ +\\ 2\sin\Theta - 2\sin\Theta\end{bmatrix} = 0 \quad (28)$$

Equation (28) shows that the total of the primary forces for any crank angle and in every plane is equal to zero; that is, the forces are balanced completely.

The total secondary force for all eight cylinders is

$$\Sigma F_{a_2} = 4Kk_2 \begin{bmatrix} \cos 2\Theta_1 \\ \cos 2\Theta_2 \\ \cos 2\Theta_3 \\ \cos 2\Theta_4 \\ \cos 2\Theta_5 \\ \cos 2\Theta_6 \\ \cos 2\Theta_7 \\ \cos 2\Theta_8 \end{bmatrix}$$

$$= 4Kk_2 \begin{bmatrix} \cos 2\Theta \\ \cos 2(\Theta \pm 180) \\ \cos 2(\Theta + 90) \\ \cos 2(\Theta - 90) \\ \cos 2(\Theta - 90) \\ \cos 2(\Theta + 90) \\ \cos 2(\Theta \pm 180) \\ \cos 2\Theta \end{bmatrix}$$

$$= 4Kk_2 \begin{bmatrix} \cos 2\Theta \\ \cos 2\Theta \\ -\cos 2\Theta \\ -\cos 2\Theta \\ -\cos 2\Theta \\ -\cos 2\Theta \\ \cos 2\Theta \\ \cos 2\Theta \end{bmatrix} \quad (29)$$

Therefore, we have

$$\Sigma F_{a_2} = 4\,Kk_2\,(4\cos 2\Theta - 4\cos 2\Theta) = 0 \quad (30)$$

which shows that the secondary forces are balanced completely.

The fourth-order harmonic for all eight cylinders is

$$\Sigma F_{a_4} = 16Kk_4 \begin{bmatrix} -\cos 4\Theta_1 \\ -\cos 4\Theta_2 \\ -\cos 4\Theta_3 \\ -\cos 4\Theta_4 \\ -\cos 4\Theta_5 \\ -\cos 4\Theta_6 \\ -\cos 4\Theta_7 \\ -\cos 4\Theta_8 \end{bmatrix}$$

$$= 16Kk_4 \begin{bmatrix} -\cos 4\Theta \\ -\cos 4(\Theta \pm 180) \\ -\cos 4(\Theta + 90) \\ -\cos 4(\Theta - 90) \\ -\cos 4(\Theta - 90) \\ -\cos 4(\Theta + 90) \\ -\cos 4(\Theta \pm 180) \\ -\cos 4\Theta \end{bmatrix}$$

$$= 16Kk_4 \begin{bmatrix} -\cos 4\Theta \\ -\cos 4\Theta \\ -\cos 4\Theta \\ -\cos 4\Theta \\ -\cos 4\Theta \\ -\cos 4\Theta \\ -\cos 4\Theta \\ -\cos 4\Theta \end{bmatrix} \quad (31)$$

Therefore

$$\Sigma F_{a_4} = -128\,Kk_4 \cos 4\Theta \quad (32)$$

Equations (31) and (32) show that the fourth-order harmonics synchronize in the vertical plane.

The sixth-order harmonic for all eight cylinders is

$$\Sigma F_{a_6} = 36Kk_6 \begin{bmatrix} \cos 6\Theta_1 \\ \cos 6\Theta_2 \\ \cos 6\Theta_3 \\ \cos 6\Theta_4 \\ \cos 6\Theta_5 \\ \cos 6\Theta_6 \\ \cos 6\Theta_7 \\ \cos 6\Theta_8 \end{bmatrix}$$

$$= 36Kk_6 \begin{bmatrix} \cos 6\Theta \\ \cos 6(\Theta \pm 180) \\ \cos 6(\Theta + 90) \\ \cos 6(\Theta - 90) \\ \cos 6(\Theta - 90) \\ \cos 6(\Theta + 90) \\ \cos 6(\Theta \pm 180) \\ \cos 6\Theta \end{bmatrix}$$

$$= 36Kk_6 \begin{bmatrix} \cos 6\Theta \\ \cos 6\Theta \\ -\cos 6\Theta \\ -\cos 6\Theta \\ -\cos 6\Theta \\ -\cos 6\Theta \\ \cos 6\Theta \\ \cos 6\Theta \end{bmatrix} \quad (33)$$

Therefore

$$\Sigma F_{a_6} = 36\,Kk_6\,(4\cos 6\Theta - 4\cos 6\Theta) = 0 \quad (34)$$

Hence, the resultant of the forces in the vertical plane is

$$\Sigma F_{av} = -128\,Kk_4 \cos 4\Theta \quad (35)$$

and the resultant of the forces in the horizontal plane is

$$\Sigma F_{ah} = 0 \quad (36)$$

Rocking Couples

Primary Forces.—By making use of equations (24) and (25), we obtain

$$\Sigma M_{v_1} = Kn \begin{bmatrix} x_1 \cos\Theta \\ -x_2 \cos\Theta \\ -x_3 \sin\Theta \\ x_4 \sin\Theta \\ x_5 \sin\Theta \\ -x_6 \sin\Theta \\ -x_7 \cos\Theta \\ x_8 \cos\Theta \end{bmatrix}$$

$$\Sigma M_{v_1} = Kn \begin{bmatrix} (x_1 + x_8)\cos\Theta - (x_2 + x_7)\cos\Theta \\ + \\ (x_4 + x_5)\sin\Theta - (x_3 + x_6)\sin\Theta \end{bmatrix}$$

But, for a symmetrical arrangement of the crank-throws, having the same phase, along the axis of the crankshaft and relative to the middle point between the end cylinders, we have

$$(x_1 + x_8) = (x_2 + x_7) = 0$$
$$(x_4 + x_5) = (x_3 + x_6) = 0$$

Therefore,

$$\Sigma M_{v_1} = 0$$

Secondary Forces.—By making use of equations (24) and (25), we obtain

$$\Sigma M_{v_2} = 4\,Kk_2 \begin{bmatrix} x_1 \cos 2\Theta \\ x_2 \cos 2\Theta \\ -x_3 \cos 2\Theta \\ -x_4 \cos 2\Theta \\ -x_5 \cos 2\Theta \\ -x_6 \cos 2\Theta \\ x_7 \cos 2\Theta \\ x_8 \cos 2\Theta \end{bmatrix}$$

$$\Sigma M_{v_2} = +\cos 2\Theta\,(x_1 + x_2 + x_7 + x_8) - \cos 2\Theta\,(x_3 + x_4 + x_5 + x_6)$$

But, for a crankshaft in which the cranks in the same phase relation are longitudinally placed relative to the middle of its length, we have

$$(x_1 + x_2 + x_7 + x_8) = (x_3 + x_4 + x_5 + x_6) = 0$$

Therefore,

$$\Sigma M_{v_2} = 0$$

Fourth-Order Forces.—Treating the fourth-order forces in exactly the same manner in which the secondary forces were treated, we find that

$$\Sigma M_{v_4} = 0$$

Sixth-Order Forces.—Similar treatment of the sixth-order forces gives

$$\Sigma M_{v_6} = 0$$

Therefore, the engine is entirely free from rocking couples, since

$$\Sigma M_h = 0 \text{ and } \Sigma M_v = 0$$

Total Unbalanced Forces

The total of the unbalanced forces for the Packard single-eight engine amounts to only 32 lb. at 3000 r.p.m. This is equal to the unbalanced primary force produced

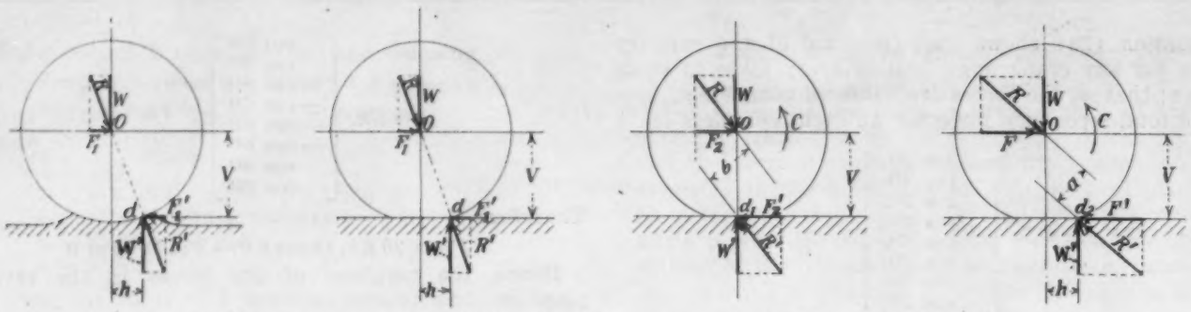


FIG. 30—DIAGRAMS OF THE VARIOUS FORCES INVOLVED IN THE ROTATION OF A WHEEL

by an accumulated difference in weight of all the piston assemblies of only 2 oz., which is a tolerance that would be utterly impracticable to work to in manufacturing. Even then, the difference in the amplitude of vibration would be only 1/36 as great, because the frequency of the sixth-order forces is six times the primary frequency. There can be no question of the insignificance of such a slight unbalance.

APPENDIX 2

DERIVATION OF THE FORMULA FOR TURNING MOMENT ABOUT THE STEERING-PIVOT

For an analysis of the forces acting on a wheel and overcoming rolling resistance, we refer to the left half of Fig. 30 and to the text of the paper under Fundamental Requirements of Brakes and Steering[4]. For a condition of equilibrium, we find

$$F_1 + F_1' = 0$$
$$W + W' = 0$$

Therefore,

$$F_1 = W\,(h/V)$$

But, r very nearly equals V; hence, we have

$$F_1 = W\,(h/r) \qquad (37)$$

For an analysis of the forces on a wheel locked by brakes and sliding with uniform motion, we refer to the right central drawing in Fig. 30 and to the text of the paper under Forces for Locked Wheels[5]. From the definition of sliding friction, we have, using f to represent the coefficient,

$$F_2 = fW \qquad (38)$$

Then, we have $F_2 + F_2' = 0$, or $\Sigma F = 0$; and also, $W + W' = 0$ or $\Sigma V = 0$. But, taking moments about O, we have a couple $C' = F_1 r$, which, to satisfy the condition for equilibrium, must be resisted by an equal and opposite couple, hence $C + C' = 0$, or $C = -C'$, this couple is necessary to restrain the wheel against rotation, in this case due to the action of front-wheel brakes and to friction at the bearings.

For an Analysis for Mixed Resistance[5], we refer to the drawing at the extreme right of Fig. 30 and to the text of the paper. For the condition of equilibrium, we have

$$C = FV - Wh$$

But, $h = F_1 V/W$ and V very nearly equals r; hence, $F_1 = W\,(h/r)$. Let $F = F_1 + F_2$, where F_2 equals rolling resistance.[5] Then, since $F_1 = W\,(h/r)$, we have

$$\begin{aligned} C &= (F_1 + F_2)\,r - Wh \\ &= Wh + F_2 r - Wh \\ &= F_2 r \\ &= (F - F_1)\,r \end{aligned} \qquad (39)$$

If we denote the coefficient of static friction by f_0, then F_2 becomes a maximum when $F_2 = f_0 W$, and we have

$$C \leqq f_0 W r \qquad (40)$$

However, the couple C may have any value from zero

[4] See THE JOURNAL, October, 1923, p. 268.
[5] See THE JOURNAL, October, 1923, p. 270.

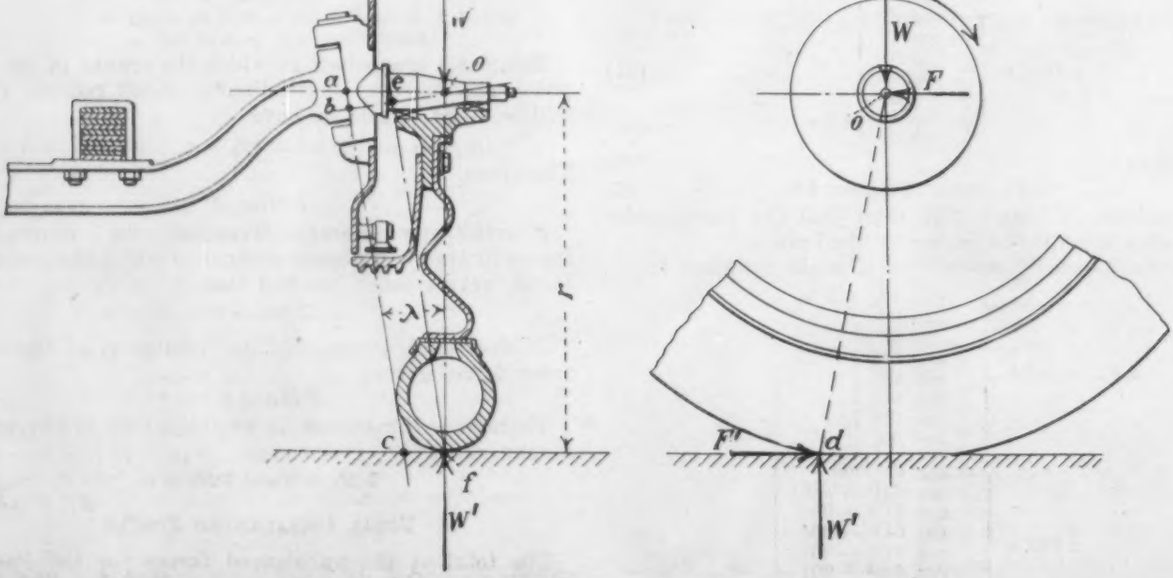


FIG. 31—DIAGRAM OF THE FORCES IN THE STEERING-KNUCKLE

to $f_s Wr$, depending only upon the friction at the bearings and the frictional moment exerted by the brakes.

Forces Acting on the Steering-Knuckle

For a general analysis of the forces acting on the steering-knuckle, we refer to the left-hand portion of Fig. 31. Let

λ = the angle made by the center plane of the wheel and the steering-pivot axis
m = the ground intercept of the steering-pivot axis and the center of contact area
F' = the horizontal force required to overcome the total resistance
F_1 = the horizontal force required to overcome the rolling resistance
W = the weight on the wheel
C = the reacting couple about the axis of rotation of the wheel
r = the radius of the wheel

The resistance F' and the reaction of the weight W' act at the point d in the right-hand portion of Fig. 31. Referring to the upper portion of Fig. 32, the weight on the wheel acts through the point O of the steering-knuckle; also, the force F acts through the point O in the center plane of the wheel.

Referring first to the right and then to the left-hand portion of Fig. 31, let the distances

$$of = r$$
$$oa = a$$
$$ob = b$$
$$oe = c$$
$$cf = m$$
$$be = e$$

Then,

$$b = a\cos\lambda$$
$$= c + e$$
$$= r\sin\lambda + m\cos\lambda$$

The lower portion of Fig. 32 represents the steering-knuckle with the wheel removed and the reactions at O replaced by the actions W, F and C, equal and opposite.

We can represent the couple C by its moment vector M. Then, resolving the moment axis M into its components M_n and M_t as in the lower portion of Fig. 32, respectively normal and parallel to the steering-pivot axis, we have

$$M_n = M\cos\lambda$$
$$M_t = M\sin\lambda$$

The moment vector M_n, being normal to the steering-pivot axis, exerts no rotative tendency about the pivot axis, but the tangential component M_t exerts a tendency of rotation which must be reacted by the steering-gear or, if it is balanced by the wheel on the opposite side of the car, it induces stresses in the tie-rod and the steering-arms.

The force F and its reaction at the steering-pivot axis forms, about the pivot axis, the couple $M_h = Fb$, in Fig. 32, which is opposite in its tendency with reference to M_t and is represented by the moment vector M_h. The resultant moment M_r is the algebraic sum of M_h and M_t, and we have

$$M_r = M_h + M_t$$

But,

$$M_h = F\,(r\sin\lambda + m\cos\lambda)$$
$$M_t = -M\sin\lambda = -(F - F_1)\,r\sin\lambda$$

Then,

$$M_r = F\,(r\sin\lambda + m\cos\lambda) - (F - F_1)\,r\sin\lambda$$

Hence,

$$M_r = F\,m\cos\lambda + F_1\,r\sin\lambda \qquad (41)$$

Equation (41) is the general equation for the net value of the couple C, due to the action of the total resistance tending to rotate the steering-knuckle about the steering-pivot axis.

Center-Point Steering

In center-point steering-design, the steering-pivot axis, when produced or extended, intersects the ground in the center plane of the wheel. Therefore, the distance cf in Fig. 31 becomes zero. Therefore, $m = 0$ and the first quantity in the right-hand member of equation (41), $Fm\cos\lambda = 0$. Hence

$$M'_r = F_1\,r\sin\lambda \qquad (42)$$

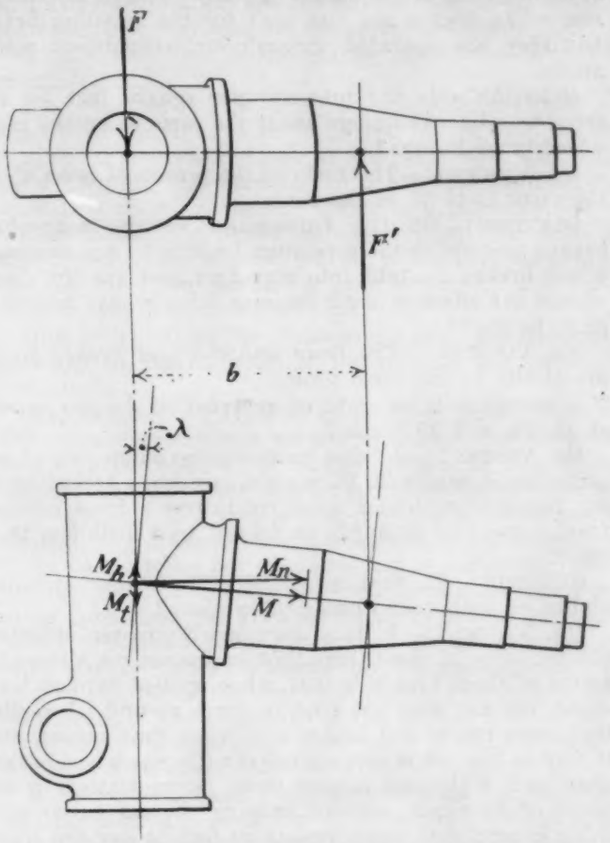


Fig. 32—Another Diagram of the Forces Acting on the Steering-Knuckle

In the equation (42), we find that the only resistance affecting the turning couple is F_1, which is the rolling resistance.

Conclusions

The conclusions drawn from this proof are enumerated as follows:

(1) The steering-linkage and steering-gear are not subjected to stress because of the action of the front-wheel brakes

(2) Steering is in no way affected by the action of the brakes. This is particularly important for, if this were not true, in case of a quick stop, if one wheel lost its traction the driving wheel would be given a strong wrench that probably would cause the driver to lose control of the car

(3) Maneuverability in parking a car, or on grades where brakes are required, is not affected appreciably when the brakes are applied. This makes it easier to maneuver the car in close or tight places

THE DISCUSSION

Question:—Are the front-wheel brakes used only as a service brake?

J. G. VINCENT:—We felt that all the braking effort that reasonably could be had was wanted in the service brakes since these are the real emergency brakes, the so-called emergency brake being nothing but a standing brake. In a car that has ability to accelerate rapidly and weighs considerable, the maximum braking effectiveness should be provided; obviously, it cannot be had on two wheels. Also, by distributing the braking effort over four wheels, wear is reduced greatly and the frequency of adjustment is decreased. In the Packard layout the rear-wheel brakes are also used for the standing brake, but they are operated through an independent mechanism.

QUESTION:—Is the pressure per square inch on the front-wheel brake-linings about the same as on the rear-wheel brake-linings?

MR. VINCENT:—The ratio of the pressures is as 45 on the front is to 55 on the rear.

QUESTION:—Do the front-wheel or the rear-wheel brakes accomplish the maximum braking? Are the rear-wheel brakes brought into play first and are the front wheels not effective until the rear wheels have begun to grip the road?

MR. VINCENT:—The front and the rear brakes go on practically at the same time.

QUESTION:—What rate of retardation do you secure at 15, 25, and 35 m.p.h.?

MR. VINCENT:—I think that our maximum rate of retardation is nearly 20 ft. per sec. per sec. According to my recollection, under ideal conditions I have stopped from a speed of 60 m.p.h. in 4.5 sec. in a little less than 200 ft.

QUESTION:—Is that practically the same stopping ability as with rear-wheel brakes alone?

MR. VINCENT:—It is a very much greater stopping ability. One of the things that impresses me about the action of these brakes is that, when applied hard at high speed, the car does not tend to jump around. I realize that some rear-wheel brakes are better than others, and it may be that some cars equipped with rear-wheel brakes alone can withstand having them jammed on at a car speed of 60 m.p.h. without causing the car to do anything except slow down smoothly; but, to say the least, that is difficult to accomplish. I think it is possible to slow-down a big car fast with four-wheel brakes in a way that cannot be done with two-wheel brakes. I want you all to understand me clearly. I am not "sold" by any manner of means on the belief that all cars ought to have four-wheel brakes. I think that we must learn much about them. We have introduced them on our expensive car because we felt that we could get the money into them that was needed to build them right. I do not know just how cheaply we can make four-wheel brakes and still have them perfectly satisfactory. I think none of us knows. I am much interested in them. I think they are coming into general use, but I am not at all certain that they are going to be used on all sizes of car. It will not surprise me if we are still discussing this question 10 years from now.

QUESTION:—How do four-wheel brakes compare with two-wheel brakes under abnormal conditions, such as on wet, greasy roads?

MR. VINCENT:—Such road conditions show-up the four-wheel brakes to their greatest advantage. I was very much surprised during winter driving in mountainous country to find that I could stop when a reasonable amount of snow was on the road almost as quickly as I would stop ordinarily on dry pavement. That should have been mentioned in the paper.

We did not make the brake leverage such as to produce what might be called "sensational" brakes. I do not believe in them or in sensational brake-exhibitions. Only very rarely does a person want to make a sensational stop; then, as was stated in the paper, a person has unusual power at his command and will apply the brakes much harder than normally. The four-wheel brakes are not intended to make sensational stops, but it is true that one can stop almost as quickly on slippery or wet pavement as one would stop ordinarily on dry pavement. I have never skidded yet except when I deliberately tried to skid when going around a turn.

QUESTION:—What is your opinion in regard to using a propeller-shaft brake as a service brake?

MR. VINCENT:—I do not favor using a propeller-shaft brake for general service. Propeller-shaft brakes serve satisfactorily for the standing brake when used in conjunction with four-wheel brakes. In the hands of the average owner, the hand-operated propeller-shaft brake is not used often in ordinary service conditions. Very satisfactory four-wheel brakes can be built for the same money as a practical propeller-shaft brake having sufficient strength provided in the axle to carry the braking loads.

QUESTION:—Have your investigations shown the necessity for the release of the outside front-wheel brake when the car is rounding a turn?

MR. VINCENT:—No. I claim that to be wrong absolutely. I defy anybody to show me how it will do any good.

QUESTION:—When descending a hill steep enough to require sufficient brake pressure to lock the wheels and approaching a sharp hairpin turn at the bottom of the hill, would locked front wheels have a tendency to hold the car to a straight course and cause it to leave the road at the turn?

MR. VINCENT:—To begin with, if the brake adjustment is correct, the rear wheels must become locked before the front wheels do and, if the car had gained such momentum that it was necessary to lock the wheels to stop it, this hardly could be considered rational driving. Certainly, if the full effect of four brakes is required to stop the car, it is evident at once that three brakes or only two brakes on the rear wheels would result in the car leaving the road. If the four-wheel brakes are good and the car is driven reasonably, it ought to be able to stop before reaching the turn.

QUESTION:—Has any investigation been made to determine the effect on the springs when four-wheel brakes are applied?

MR. VINCENT:—Much investigation has been necessary in connection with the front springs. However, when the springs are designed properly, they should not be affected to a degree that will have anything to do with the steering. The Hotchkiss drive will develop chatter if its linkages are not designed properly. We can do the same thing with front-wheel brakes. We must study our geometry. I think it is proper design to have the front-wheel brakes tend slightly to unwind the brake. By this I mean that if the brake is applied hard and the car slows-down quickly, the brakes should unwind a little rather than wind-up. If they wind-up, some trouble in the form of chatter is encountered. If the brakes are put on hard and the action tends to put them on still harder, that will be a very severe brake and, in the case of the wheel being thrown off the road by a stone, rut or crossing, the wheel will become locked while in the air and when it comes down it will catch, release, jump in the air again and cause a very violent chatter. I have

experienced that in the experimental stages. We have to design the linkages so that we will not run into that situation. Of course, we do not want to have the brakes unwind very much, because that would detract from the braking effort too much. On the other hand, if we happen to put the brakes on when we are backing-up, we would get the chatter if the action were too great. The action should be practically zero, of course.

QUESTION:—That is caused by the weight of the car piling-up on the front springs, is it not?

MR. VINCENT:—Yes, and by the deflection of the springs that allows the axle to twist a little.

QUESTION:—Has any tendency been noted for a car to list toward the edge of the road or down off the crown of the road?

MR. VINCENT:—I suppose that question refers to driving on the crown of the road and then putting on the brakes, and to the tendency for the car to swerve off to the side. Of course, that would be true if the front axle were not designed properly or if the brakes were not equalized properly. I have had some experimental cars that did just that. The car was not partial as to which side of the road it took. It depended upon which brake was adjusted tighter. I feel that the king-pin axis must practically intersect the point of tire contact, and then the brakes must go on practically equal. They must be equalized and designed so that there cannot be any great difference in the efficiency of each brake.

QUESTION:—Do you anticipate any trouble from cables seizing in the cross-tube due to rust and corrosion or failing to equalize? Is lubrication provided for?

MR. VINCENT:—We use galvanized cable and the whole assembly is rust-proofed before painting. I do not anticipate any trouble. Of course, the movement is not great; so far as the rear brakes are concerned, it is not 1/16 in. in 6 months. The front cables operate a little every time we turn so that, probably, they will be kept free, and so will the pulleys. I do not say that the mechanism cannot get stiffened-up by corrosion and dirt, but it is pretty well protected.

QUESTION:—In reference to having the king-pin axis intersect the center of tire-ground contact, what is the angle of the king-pin and of the steering-knuckle?

MR. VINCENT:—Theoretically, the axis extended intersects the tire-ground contact. Its angle is 10 deg.

QUESTION:—What is the effect of having oil on one front-wheel brake?

MR. VINCENT:—About the same as having oil on one rear-wheel brake; to make it inefficient. If the brakes are put on to make a quick stop, some of the braking power is lacking. On account of the arrangement of the king-pin, we would not get any decided pull to one side of the road. We might do so under certain conditions, as when the tire rolling on one side of the road gets a slight pull, but nothing serious would occur to interfere with steering. The result would be very much reduced efficiency in the brakes. The only thing we can do as to that is to design to keep the brakes as dry as possible. I have not experienced the condition mentioned. Probably it will occur under certain bad conditions on the outside of the road, but it is pretty well guarded against.

QUESTION:—Of what material are the transmission gears and shafts made?

W. R. GRISWOLD:—We use an oil-treated chrome-nickel steel for the transmission gear.

QUESTION:—What type of gear-tooth is used, involute or stub, and what is the pressure angle?

MR. GRISWOLD:—All modern gear-teeth are of the involute form. That is the only type of gear-tooth that can be reproduced easily by methods that are available. So far as the design of the tooth is concerned, that is entirely special. The pressure angle is about 18 deg. 45 min. Compared with a full-depth Brown-and-Sharpe tooth, the tooth is shorter. However, the addendum and the dedendum of the teeth are not equal. They vary in such a way that the number of teeth in simultaneous contact, or the overlap in the engagement of one tooth to the next, the sliding factors and the tooth pressures or unit pressures between the faces of the teeth, are coordinated in a way that we desire to have them.

QUESTION:—What is the engine compression-pressure, gage?

MR. VINCENT:—The compression-pressure, gage, is approximately from 75 to 80 lb. per sq. in. with the engine warm and cranked over at 120 r.p.m. with the throttle wide-open. All readings on a pressure-gage depend upon how they are made. We have a fixed method of taking them. The speed we use is about the same as that at which the electric starter will crank the engine. We aim for 77 lb. per sq. in. gage pressure. The maximum torque is about 2730 lb-in.

QUESTION:—Does the single-eight offer any particular economy in fuel? What is the mileage per gallon of gasoline?

MR. VINCENT:—Gasoline economy is purely relative. The more excess power we put in the car the worse the fuel economy will be. I usually hesitate to give figures on fuel economy; they depend too much on how the car is operating. If I take a new properly adjusted car, at Detroit, on a 500-mile run, it will average anywhere from 12 to 14 car-miles per gal., but that is for straightaway driving and not for city driving. Under average operating conditions the year through one should get somewhere around 10 miles per gal. I do not say that we offer any particular economy in fuel-consumption over that of any car of the same power; but I do believe that, on account of the simplicity of the engine, it is easier to maintain it in reasonably good working order so that it will give somewhere near the economy it should give.

QUESTION:—Having the brakes arranged so that they will not lock is a good way to save tires. What conditions are chosen? Is there some specific coefficient of resistance with the road?

MR. VINCENT:—That matter is not clearly answered in the paper. It is a difficult statement to make clear but, under ordinary dry-pavement conditions, it is very difficult to lock the wheels if there is anything like the proper brake adjustment. It can be done. The rear wheels will lock first; it is very unusual to be able to lock the front wheels, but so long as the human element is involved and so long as the brakes are made relatively efficient, there will be a possibility of locking them. That is my reason for believing that brakes should not be so sensitive that they can be locked easily. However, I do not think that the average person would lock them except under very extreme conditions. I do not say that the wheels cannot be locked, but that it is very difficult to lock the front wheels.

QUESTION:—What is the ratio of the thrust to the radial load on the steering-worm bearings?

MR. GRISWOLD:—The reference is, I understand, to the bearings, top and bottom, of the worm. The radial loads are relatively very small. In fact, they might even be neglected entirely, because the thrust acts along the center-line of the worm-shaft. I do not recall what the thrust loads are.

QUESTION:—Has the reduction in friction in the steering connection produced any tendency to wheel-wabble?

MR. VINCENT:—That is a very nice problem to get around because it certainly is true that anything which can be steered easily from the steering-end standpoint will be fairly easy to work back through the other way. I think we all agree that, for high-speed, powerful cars, it is very dangerous to put in irreversible steering. It will simply result in breaking something. Irreversible steering will not stop the wheel-wabble or the so-called "shimmy."

The first edition of the present axle was of about the same shape as it is now, but it produced wheel-wabble of the ordinary variety that occurs at low speed. In checking that up, I found it easy to correct by reducing the fore-and-aft rake-angle of the king-pin or the inclination back to the front. The first angle was something like 3 deg.; I could eliminate the wabble by reducing that angle to 2 deg. However, later on, when we got to experimenting with various kinds of big tire, we ran into some other kinds of wheel-wabble at high speeds and found it necessary to reduce that angle still further. Now, it is an angle of 1 deg. with the car fully loaded, and of about 1¼ deg. with the car unloaded. We find it very important not to have too much angle. Since we settled that angle question, I have been unable to make the car shimmy at high speed, and we have had no trouble when driving at low speed except when I experimented with some of these new tires.

QUESTION:—How does the four-wheel-brake construction operate on the single-eight when balloon tires are used at high speeds?

MR. VINCENT:—So far as I know, the four-wheel brakes would operate very well. The balloon tire has many good features; one, in particular, is that it certainly grips the pavement well; so, I imagine one would stop a car very quickly if the brakes were put on hard enough. I have not tried to stop at very high speed, because I have not been able to get up very high speed without wheel-wabble with the balloon type of tire.

QUESTION:—We see that the short V-type engine has been abandoned in favor of a long straight-line engine. This is just the opposite of the development that the aircraft engine has had in the last 10 years. The long straight-line engine has been abandoned and I believe that the short V-type engine is now leading. Can Mr. Vincent predict from his experience with the single-eight engine whether anything similar will be the case in the aircraft engine?

MR. VINCENT:—I think not, except that we might have a twin-eight engine for large powers. When we try to use aircraft ideas too far in our automobiles, or vice versa, or try to mix up car design and truck design, we get into considerable trouble. We learn much in each branch of the art but we have to be very sure to analyze the problems of the particular job before us. In the case of the aircraft engine, I am not in full agreement with the statement that we have abandoned the long engine for the short engine. We have abandoned long engines for long "double" engines, if one may put it that way, because we have gone up in power and we have to use two rows of cylinders just about as long as the single row was in the first place. I think that the eight-cylinder V-type engine will not continue to live in aircraft work. I think that the light high-powered, 12-cylinder engine will be the standard aircraft engine, at least for Army and for Navy work. Twin-eights, or 16-cylinder engines, have been built, and it is entirely possible that there will be a development along that line; but I believe that, for aircraft work, the 12-cylinder engine will be used in increasing numbers because it is the lightest engine in weight per horsepower that can be built.

QUESTION:—The use of cables for controls on airplanes has been almost discontinued, largely because of the exceptional strain on the cable. Why, therefore, do you turn to cable for your brakes rather than to the bell-crank as used in aircraft construction?

MR. VINCENT:—I can answer that best by saying that we do not have the same sort of conditions at all, although I cannot agree with the statement that the use of the cable for aircraft work has been discontinued. There is a movement in that direction, but the problem involved is entirely different from that in motor cars. In the airplane we want to get movement in both directions; therefore, we have to run cables clear around and that creates considerable friction in itself. We want to get the easiest possible control on the airplane, the best touch. That is very different from just pulling on the brake-shaft. I do not know of any way to equalize brakes simply as well as it can be done with cables. I do not say that that is the ideal way, but it is the best way I know.

CAUSES OF ACCIDENTAL DEATHS

IN the report of the committee on accident prevention of the National Safety Council, which was submitted at the recent Safety Congress at Buffalo, the chairman of the committee, Dr. Louis I. Dublin, statistician of the Metropolitan Life Insurance Co., had the following to say about the relative seriousness of the different hazards principally responsible for fatal accidents in this country in recent years:

> The committee estimates that in 1922 14,000 deaths in the United States were due to automobile accidents alone. In 1911 the number was only 2061. In the preceding years automobile accidents accounted for 2.6 per cent of accidental deaths. In 1922 the automobile was the chief cause and accounted for 18 per cent of the total accident mortality budget. The accompanying table presents a comparison of the estimated fatalities in the United States during 1922 and for the three other calendar years of 1911, 1920 and 1921. —*Economic World.*

CAUSES AND ESTIMATED NUMBER OF ACCIDENTAL DEATHS

	1922	1921	1920	1911
Accidental burns	6,009	6,362	8,088	7,214
Accidental drowning	6,992	7,872	6,066	8,806
Accidental falls	12,782	12,293	12,557	14,052
Traumatism by machines	3,168	1,941	2,660	1,967
Railroad accidents	6,883	6,362	7,769	12,179
Automobile accidents	13,875	12,293	11,067	2,061
Street car accidents	1,748	1,725	2,128	2,998
All fatal accidents	75,272	73,542	75,983	79,255

Research Topics and Suggestions

THE Research Department plans to present under this heading each month a topic that is pertinent to the general field of automotive research, and is either of special interest to some group of the Society membership or related to some particularly urgent problem of the industry. Since the object of the department is to act as a clearing-house for research information, we shall be pleased to receive the comments of members regarding the topics so presented, and their suggestions as to what might be of interest in this connection.

OBSERVATIONS ON THE AUTOMOTIVE AND HIGHWAY FIELDS IN EUROPE

TO those readers of THE JOURNAL who are interested in the many new developments that have come crowding upon one another's heels during the past 12 months of the automotive industry's history, the following notes, made more or less at random in the course of a short trip through England, France and Germany this summer, may be of interest. These notes, covering aspects of the industry that seemed most interesting to an American observer, are given under subject headings for the convenience of the reader.

HIGHWAY CONSTRUCTION METHODS IN ENGLAND

Upon the subject of highway construction, the observations of Col. R. E. Crompton, equally well known as an authority in this field and as the inventor of the tanks, were of interest. His paper, read before the Institution of Mechanical Engineers in 1916, described the British construction methods with great thoroughness, and so far as he is aware there is nothing new to report since that date. His particular concern at the present time is for the support of the sides of macadam roads cross-tied together to prevent spreading.

MACADAM ROAD SURFACING

Colonel Crompton described his method of producing a satisfactory macadam surface when the roadbed is old and solid. This is somewhat as follows: First scarify the old surface, taking off the material and cleaning it; then add about an equal amount of new material about the 2-in. size and roll into a compact surface between the side buttresses. Put over these a layer of new stone about ¾ to 1 in. in size, of a type of material that breaks into almond-shaped pieces; this may be broken from some of the old material. This is brushed to get it to stand on end in the interstices of the larger stones and then rolled hard. Next a layer of asphalt or pitch is applied to consolidate this surface, after which a ¾-in. layer of top dressing broken from the old road is added. Finally this is put down with pitch mixed with the correct amount of fine material, 200 mesh or so, which is, as well as not, recovered from the old road material.

For British service, which can rely upon good road foundations and where there is still much heavy steel tire traffic, Colonel Crompton thinks roads of this type are preferable to cement. The latter has not been found entirely satisfactory, while the macadam roads made as above have shown remarkable life. He also has a plan for the continuous upkeep of such roads, which he estimates to be very inexpensive, perhaps sixpence per square yard, and to be applied only once in 2 or 3 years.

HIGHWAY UPKEEP AT TRIFLING COST

This calls for a train of vehicles drawn by a tractor and covering about 6 ft. wide at a speed of 1 m.p.h. First the road is swept clean, then comes a machine to spread the surfacing stone of ¼ to ½ in. in size. After this is spread evenly, a tar-wagon throwing a high-velocity spray of pitch with superheated steam into the stone follows and then a roller or two that compacts the whole. If this process is applied at reasonable intervals, he thinks the road should be permanent. This seems likely, provided the foundations are good.

In general it seems that much of the difference in quality of road work in England and in the United States is due to a great difference in the care, skill and intelligence of the workmen and foremen who do the work on the road. So great is the difference between British and American conditions in these respects that the difference in road due to this cause alone may easily average 3 to 1.

RUBBER ROADS FOR QUIET ZONES

Another noteworthy item was a sample of the rubber road that is being laid to surround the Cenotaph in Whitehall, the object being the reduction of noise in this particular locality. This consists of a concrete brick with a layer of about ⅜-in. of rubber vulcanized all over it. The rubber is very hard, much more so than tire rubber. The surface of the concrete has pits into which the rubber is vulcanized to add to the adhesion. This type of road is found very effective in the neighborhood of hospitals. Other roads of the same material now in use show almost no measurable surface wear, and long life is predicted for this comparatively thin layer of rubber.

LONDON GENERAL OMNIBUS SERVICE PLANT

At the Chiswick works of the London General Omnibus Co. is a most interesting example of the application of real organized production methods to the systematic overhaul of buses. It is a police requirement in London that all public service vehicles shall be taken down and overhauled once every 12 months. Based on this requirement the system described below has been worked out.

DISMANTLING AND OVERHAULING

Every morning, about 25 buses come into the service plant. First the body is removed to a special elevator, after which the chassis is driven around to the take-down line, while the body is taken to the body works. In the latter section the entire body is gone over for repairs, replacements or necessary modifications, in case standard fitting has been changed. After being repaired the body is entirely repainted from the surface up, in three coats. This operation requires not more than 48 hr. In the take-down line the chassis is completely dismantled, even every brace and bracket being removed from the frame. The only bolted parts that remain are the bolted-in cross members.

The engine is taken off at one distributing center, the transmission at another and the rear axle at a third. Each of these units is broken down to the very last piece and the dismantled parts are then passed through a cleaner in which they are subjected to high-pressure sprays of hot caustic solution that remove all grease and dirt and leave all parts perfectly clean, except the pistons, which have to be freed from carbon deposit. These cleaned parts are then distributed on several lines of rollers, six lines being devoted to the engine, and at the end of each line the parts of a kind are fed at random, each into its own repair or receiving line. Here each part is inspected, measured,

marked for the standard to which it belongs or rejected if worn out or imperfect. From this collecting line each part or group of parts goes through a repair line like a production line for whatever process is necessary.

INTERCHANGEABLE STANDARD PARTS

A very interesting feature of this system is, that each part has anywhere from two to nine or more standard sizes and the recovery process involves refinishing all worn parts to the next size. There are two standards for cylinders, and each pair of cylinders that is worn beyond a certain number of thousandths is reground and burnished to the second size, which is 1 mm. (0.03937 in.) larger in diameter. Incidentally, all work is in metric sizes except the tolerances, which are in thousandths of an inch. For crankshafts there are nine different standards, each 0.5 mm. (0.01969 in.) smaller than the last, and within each standard the parts are absolutely interchangeable. Tolerances are ± 0.0005 in. The finished recovered parts go through to an assembling line, and the engines, transmissions, rear axles and finally the entire vehicles are assembled in the usual way. The chassis goes through to an assembly platform moving at the rate of 14 in. per min. Engines are all run-in on electric stands, as is the best practice for new engines.

The entire process is completed so rapidly that it is possible for a frame that goes in for overhaul in the morning to come out the same night in a complete bus and go on the road for test the next day. Of course, it could not carry the same body and some of the parts do not get through in that space of time, but most of them do.

REFINISHING OPERATIONS

In the refinishing operations, such as regrinding crankshafts, a stock of each standard is allowed to pile up at the bins, so that the operatives can work all day on one size standard to avoid loss of time in setting the machines. The same is true of some other parts. The setting of the shaft and the connecting-rod bearings is interesting. The babbitt is die-cast into the bronzes, which are put into the dies hot from the tinning bath. Oil-grooves, etc., are cast in and the amount of extra metal is only very little. These are cleaned up on the outside and when mounted in the crankcase are set-up tight and reamed on a special reamer that is also a burnisher. This tool has a reverse twist on the cutting and burnishing edges and the latter are shaped like dull cutting edges. This brings the liners to a beautiful finish. Absolutely no handwork is done on them and the fits are perfect. A special set of guides on the reamer insures alignment.

Cylinders are finished by hard steel burnishing rollers. It is claimed that this process adds 2 months or more to their life, say 5000 miles.

TESTING THE OVERHAULED CHASSIS

After assembly the chassis rolls onto a pair of drums that start the engine through the rear wheels and a driver takes it away. This driver, who is a special inspector and adjuster, is given 5½ hr. to see that this chassis is in perfect shape by driving it around a test track on the grounds. He makes minor adjustments himself, but reports back defects other than these to the repairs department, which handles them. Sometimes these inspectors report a whole sheet of minor troubles. Another factor that makes for efficiency is the fact that the system itself tends to pit one group against another so that nothing is shirked. Every engine is overhauled once between the general annual overhauls, that it, once every 6 months, and this is done with the same thoroughness as described above. On the average, it takes only 29 man-hours to do this job.

A REMARKABLY CENTRALIZED SYSTEM

The Company has some 30 garages in the city of London and operates about 4000 buses. These garages make minor adjustments such as those on brakes, but hardly any repairs. In fact, hardly any are necessary. The main units are all easily removable and in case anything goes wrong the garage replaces the whole unit, be it engine or steering-gear, and sends back the damaged unit to the main repair station.

MINIMUM MAN-POWER USED

One feature of the plant is the small number of unproductive employes. The system of passing work along is so well organized that no man-power is used for it. The office staff is correspondingly minimized. Altogether about 2500 men are employed at the plant. Assuming that the Company operates 4000 buses, this leaves a little over one-half a man's time for each bus. Since each bus is a 56-passenger vehicle with an infinite life, the upkeep cost would appear to be very reasonable. The expression "infinite life" is used to convey the idea that there is no obsolescence, except for scrapped individual parts. Bus fares in London vary in proportion to the distance traveled, but the average is probably less than 5 cents.

PRODUCTION

NOTHING remains stationary. Advance or decay is the law both in nature and commerce. Production methods and machine tools are constantly improving, and these forever decrease the value of their products. While the price remains unaltered, less value for money is being given. Price, however, rapidly finds its level, and only those first in the field reap the initial advantage of the new methods. The others, finding that they must come into line on a price basis, under the compulsion of necessity adopt improvements in production without experiencing any of the benefits that accrued to the first comers for a very brief period.—*Automobile Engineer.*

THE AUTOMOTIVE INDUSTRY

THE magnitude of the automotive industry is well illustrated by recent publications indicating an annual production of approximately $3,000,000,000, while petroleum, the second greatest industry, is credited with only two-thirds of that figure, and the cotton industry is shown with an annual output of just about 40 per cent of the leader. In the insurance world, it is second only to the principal line, that is, fire insurance.—W. B. Burpee.

Research an Important Factor in Highway Improvement

THE third annual meeting of the Advisory Board on Highway Research of the National Research Council was held at the headquarters of the Council in the City of Washington, on Nov. 8 and 9, 1923. The fact that advances in engineering knowledge evolve from investigation in new fields of research was indicated most clearly by the report of Dr. W. K. Hatt, director of the Board. In contrasting the present status of highway problems with that which obtained only 3 years ago, when the Advisory Board was inaugurated, he left no doubt as to the accomplishment of great progress during the period.

At the earlier date it was stated that no engineer could then build a concrete, bituminous or brick road with any certainty that it would carry traffic of motor trucks under specified conditions without breaking rather than gradually wearing under the loads imposed upon it. On the other hand, the experienced highway engineer of today, by using available information, can choose materials and design the section with reasonable assurance that it will withstand the specified conditions of service.

This raises the question of the adequate analysis and prompt distribution of the results of research, two extremely important factors in their most effective application. Activities of the Advisory Board in disseminating such material in published form and otherwise and in helping to coordinate the work of various research agencies were mentioned. In this connection it was suggested that the Board might well inaugurate an information service capable of maintaining better contact between highway engineers and the sources of information.

The director commented upon the work of the research committees and emphasized the desirability of making available for the problems of the Board more of the time and energy of the workers whose activities are now necessarily directed only in part to Board matters.

Doctor Hatt reviewed briefly the activities during the year of the various research committees and discussed the cooperative relations existing between the Advisory Board and other organizations, which number about nine, including the Society of Automotive Engineers.

It was stated in a report of the sub-committee on tractive resistance, which functioned under the leadership of Major Mark L. Ireland, that a large amount of data has been accumulated, some of which has already been distributed in preliminary reports. In concluding his report, Dr. Hatt discussed ways and means. He also enumerated the publications issued by the Board and listed the public addresses of the director.

Economic Theory of Highway Improvement

Characterizing the committee on Economic Theory of highway improvement as an informal association of men engaged in a certain line of research, Chairman T. R. Agg gave a brief account of the field that the committee seeks to cover and the progress already made. Projects on which results have been published, or are in process of publication, are truck performance on grades, rolling resistance and related characteristics of roadway surfaces, cost of motor-vehicle operation, economics of highway grades and quartermaster tractive resistance of roads research. Projects in progress include wind resistance of motor vehicles, relation of road type to tire wear and further investigation on the first three topics above.

Some of Those Who Attended the Meeting of the Advisory Board on Highway Research

Research on Tires

The work described in this report was carried on at the Bureau of Standards with a view to establishing a better basis for tire purchases. The chief problems in connection with tires were mentioned, a laboratory endurance testing machine was described and a series of tests outlined which would be of value to the Government in making purchases and to manufacturers in determining a standard test for the tire industry in general.

Deceleration Tests of Automobiles

Recent developments in the measurement of braking characteristics of automobiles were discussed by W. S. James of the Bureau of Standards. The interesting features of a new decelerometer, described in detail in this issue of The Journal on p. 499 were explained. Tests with this instrument have shown that high tire-pressure is an important factor in causing irregular

stopping. A surprising feature of the tests to determine coefficients of friction on surfaces ranging from plate glass to mud was that in all cases except on muddy surfaces the coefficients are greater for sliding than for static friction, also that the highest coefficient was found on plate glass. Mr. James stated that his instrument and method offer a convenient means for an inspector to check the condition of brakes on any car. Furthermore, this method might serve as a basis for legislation regarding brake capacity.

Structural Design

A. T. Goldbeck, chairman of the committee on structural design of highways, reported research work on the subgrade, which comprised capillary moisture tests; the devising of apparatus for testing soils under many subgrade conditions, including a new slaking test and a new method for making soil cylinders; the determination of different physical properties of soils at various depths and under various conditions; information upon colloids in clays; data on 13 clays from 10 different counties in Ohio; besides the Bureau of Public Roads tests having as their aim the standardization of physical tests for subgrade material, the determination of efficiency of admixtures and tests to determine the laws of moisture in the subgrade. Other subjects mentioned in the report were principles and methods for sand-clay, top-soil, and semi-gravel road construction; forces on pavements resulting from traffic; conclusions drawn from the Pittsburgh and from the Bates road tests; and a theoretical analysis of stresses in road slabs: The report included 26 topics suggested for further research.

Mechanics of Stiff Road-Slabs

The behavior of road slabs when supported on an elastic subgrade and loaded in different ways was discussed by Dr. H. M. Westergaard, of the University of Illinois, who has made a mathematical study of the subject. He showed equations and curves illustrating the distribution of stress in various types of slab under distributed and concentrated loads applied at the edges and also at the center. It was evident from Doctor Westergaard's mathematical treatment that it offered possibilities of solving numerous problems of concrete road design.

Character and Use of Road Materials

H. S. Mattimore, chairman of the committee on the character and use of road materials, listed in his report the 12 problems undertaken and stated briefly the progress made in each case. Among the definite conclusions reached as a result of this investigation were the following:

> The strength of Portland cement concrete varies with the amount of actual solid material present in a given volume and with the relative parts of this volume that are cement and aggregate. . . . Other conditions being the same, the grading of the aggregate has a decided effect upon the amount of water that can be used to yield a workable mixture. . . . Concrete when tested in the wet condition shows a decrease in strength from that which is tested dry.

Objectives of Highway Research

Thomas H. MacDonald, director of the Bureau of Public Roads, delivered a brief address on the subject of Objectives of Highway Research. He strongly emphasized the need for study on the basic problems of highway design and pointed to numerous instances in which the results of apparently insignificant researches have contributed to success in various engineering lines. He called attention to the immense field still left unexplored. In connection with the problems of highway transportation, he made a plea for a better recognition on the part of the public authorities of the importance of research in this general field.

Land Grant Colleges Cooperate

Anson Marston, dean of Iowa State College, presented two reports on behalf of the Association of Land Grant Colleges. He pointed to the great advantages offered by these institutions for research work on highways and mentioned the fact that in 1923 they have expended about $550,000 in engineering research. Furthermore, he stated that research on highways has been undertaken in the colleges of 24 of the States.

Highway Finance

After enumerating some of the economic and social advantages resulting from highway improvements and mentioning the chief faults in present methods of highway financing, Mr. J. G. McKay, chairman of the committee on highway finance, named six chief sources of funds for this work, recommended the budget system and gave as the two distinct problems involved in highway finance: (*a*) an equitable distribution of the cost among the several sources of revenue and (*b*) the question of the use of credit. He stated the conclusions based on the analysis of the sources and expenditures of highway funds in four representative counties and named three courses that may be followed in reducing real property taxation for highway improvements, advancing the opinion that where increased revenue is needed, it should come from the highway user whose demand for highway service is largely responsible for highway improvements.

Highway Research in North Carolina

Charles M. Upham, State highway engineer of North Carolina, gave a very interesting illustrated talk, explaining the methods used in the State of North Carolina to overcome the serious difficulties encountered in the demand for reasonably satisfactory highways in a State where the taxable property and the funds available for construction are extremely limited. In contrast with early primitive conditions in his State, he showed a number of apparently well-constructed and satisfactory modern highways, the methods of construction of which were interesting for their unusual character. One type of road consisted of nothing other than the native sand with a comparatively small amount of bituminous binder, the road being built-up by careful processes that result in a very satisfactory highway. It was demonstrated that good results can be obtained by the application of ingenuity and originality where conditions render the usual methods of construction impossible.

Highway Traffic Analysis

The importance to highway engineers of the traffic census and transport survey were brought out in the report of G. E. Hamlin, chairman of committee 4 on highway traffic analysis. In emphasizing the difference between the census and the survey, Mr. Hamlin stated that the former gives information pertaining to the traffic using the highway at the time the census is

(*Concluded on p.* 510)

Photoelastic Method Applied to Rigid-Airship Research

By THOMAS H. FROST[1] *Illustrated with* PHOTOGRAPHS

THE photoelastic method, concerning which extracts have been published[2] previously, is an optical method for the determination of stresses in all types of structures. A model of the structure, made of some transparent isotropic material, is subjected to stress under polarized light. The resulting image when projected on a screen is highly colored because of the temporary birefracting power of the material when stressed. Analysis of these colors determines in most problems the existing stresses within an error of from 2 to 5 per cent. This photoelastic method, though applicable to all structural problems, realizes its greatest importance when used for determinations of stress in mathematically indeterminate structures of which rigid airships are an extreme example.

In the design of rigid airships, a problem utterly different in many respects from all other types of construction, it becomes necessary for the engineer to depart radically from the more or less conventional methods. Naturally, the primary requirement that always must be kept in mind during calculation is the saving in weight wherever this is possible.

To effect this saving a peculiar combination of girders and steel wires has been adopted. The lightest structural metal obtainable, duralumin, is used throughout, and the factor of safety has been cut down to a figure that would be instantly condemned in any other field of engineering. Considering these facts, it becomes apparent at once that extreme accuracy of design and calculation and perfect construction are vital for the safety of the ship.

The design of the new Navy dirigible, the ZR-1, which was constructed at Philadelphia, and Lakehurst, N. J., has been based on the German Zeppelin, L-49, captured by the French in 1917. While the ship was under construction, the Bureau of Aeronautics of the Navy Department decided to carry out photoelastic tests at the Massachusetts Institute of Technology, to determine the stress distribution with the ship in flight. This work has been carried out by Dr. Paul Heymans, assistant professor of theoretical physics, who established the photoelastic laboratory, and myself, in cooperation with the Bureau of Aeronautics through C. P. Burgess, aeronautical expert for the Navy Department.

[1] Resident associate in photoelasticity, physics department, Massachusetts Institute of Technology, Cambridge, Mass.

[2] See THE JOURNAL, October, 1920, p. 393.

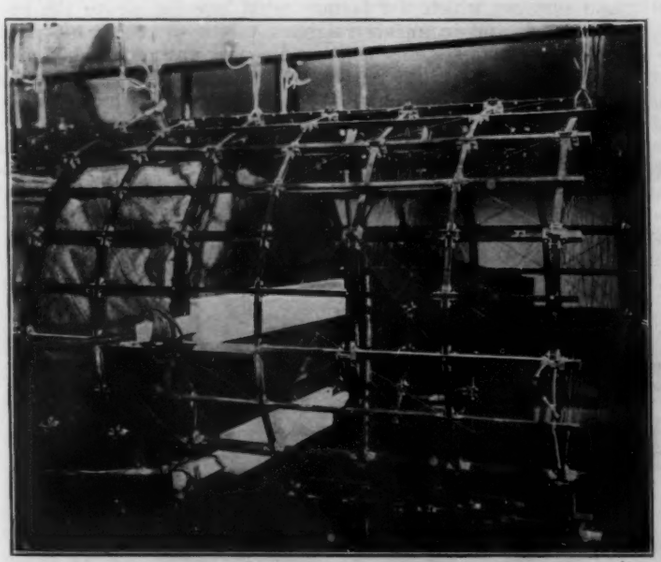


FIG. 1—SIDE VIEW OF THE MODEL OF THE ZR 1 ON WHICH THE TESTS WERE MADE

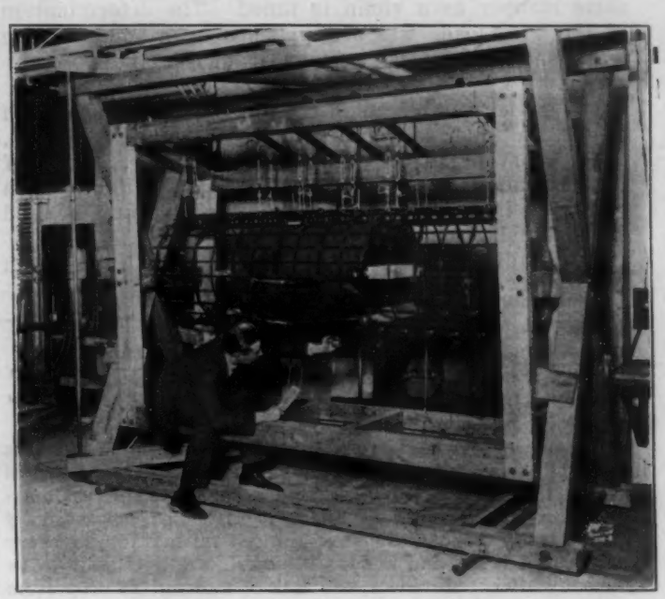


FIG. 2—THE MODEL IN PLACE IN THE LOADING FRAME

THE MODEL

The model shown in Fig. 1 embraces the seven central frame-spaces of the ZR-1 and is constructed on a scale of approximately 1 to 33 of the actual dimensions of the ship. The individual girders are not triangular lattice-work as in the actual ship, but are plain rectangular sections that have been calculated under imposed conditions of elastic similarity, to assure the same distribution of stress when the model is loaded that would arise in the actual ship under flight conditions. The girders of the model are made of pyralin, a transparent material of camphorated nitro-cellulose base, to allow the free passage of a beam of polarized light.

On account of the change of shape of the girders for the model, the joint system used in the actual ship could not be used in the model. A system of bolts and angle-plates was devised to assure rigid joining.

The wires of the longitudinal-shear wiring system must be placed under certain known initial tension during the construction of the ship. In the model, since

various tests of different nature were to be carried out, it became necessary not only to place the shear wires under known initial tension, but also to provide for changing this tension at will. In order that this could be done, the terminals of the wires were passed through holes in the ends of small tapered pins that fitted into tapered holes in the small steel hardened plates covering the joints. The pins were turned with a key, with the result that the wires could be stressed in much the same manner as a violin is tuned. The determination of the wire loads was accomplished by a small Larson tensiometer that was specially made for these experiments.

The model was placed in the loading frame, shown in Fig. 2, the inner section of which, containing the model, could be swung through any desired angle. This, of course, made it possible to pass the beam of light, which remained in a horizontal plane, through any desired longitudinal girder.

The loading of the model has, in most cases, been simulated by dead weights suitably disposed about the framework. To represent the gas-pressure forces from which a considerable fraction of the existing secondary stresses arise in the actual ship, the model was equipped with water-tight bags in the three central frame-spaces, which were filled with water while the model was in an inverted position, keel upward. The model has been tested during the last 4 months for various stress conditions corresponding to positions of the ship in flight.

This investigation, which may without exaggeration be said to be the largest photoelastic stress determination yet attempted and the only one of its kind, is the first of a large series to be carried out at the Massachussets Institute of Technology. Since the establishment of the laboratory by Dr. Heymans, the volume of the work handled has been steadily increasing. At the present time steps are being taken to duplicate the present apparatus so that the laboratory can cope with the large number of problems presented by industrial organizations.

THE PRICE OF WHEAT

THE price of wheat from day to day in central markets is a consensus of world opinion as to its value, with all factors in the situation taken into account. The local markets where the farmers sell are more restricted, but the daily papers carry the quotations of the central markets to every village and farm, and the local markets are not likely to be far out of line. Moreover, the task of moving the crop from the farms to the central markets is quite distinct and different from that of attempting to control the latter. The farmers' cooperative elevators can operate with little risk because they have the hedging facilities of the central markets; but when the farmer sets out to operate independently of the markets, or to control the markets, he takes his place with the other speculators, with possibly one economic factor in his favor, to wit, ability to carry his own wheat in his own granary at lower cost than it can be carried in the centers.

Of course, there is no reason why the farmer should not make the most of this single advantage which he has over the speculators, whenever prices fall below the normal level indicated by production costs; he is on safe ground there, and the stabilizing influence of farm reserves would be beneficial to the markets. It is quite impossible, however, that any association of farmers, no matter how many are included, ever can adjust prices to suit supply and demand as readily and effectually as the present system of free trading does it. No single group of men can fix the market price of a world commodity. That idea is a fantasy.

If too much wheat is being grown, production should be reduced, but that is best accomplished by having each individual producer free to adapt his policies to his own conditions, rather than by having every producer reduce his acreage in accordance with instructions from headquarters. In the first place, the officials at headquarters are fallible and may blunder. In the second place, all farmers are not growing wheat under the same conditions or at the same cost. All the Government inquiries into the cost of growing wheat have shown a wide range of variations. All farms are not equally suitable for growing wheat; some can be shifted to various crops more advantageously than others. Some farmers have help enough within their families to farm all the land they have, while others are obliged to hire help, and there are other conditions which may have bearing upon the advisability of curtailment in individual cases.

The chief cause of agricultural distress today is not low prices for agricultural products, most of which are above the pre-war level, but the arbitrary and short-sighted action of labor organizations in maintaining the cost of the goods and services which the farmer must buy far above the pre-war level, and in unfair relations to the prices of his products. The farmers may hold conferences until doomsday without getting any relief unless that disparity is reduced. The entire issue at last is over the terms upon which the exchange of services shall be made. The advantages of group-bargaining to employes would be almost wholly lost if the compensation of all workers, including farmers, was advanced at once. There are practically no gains except what they are clever enough to get at the expense of each other.—National City Bank.

Decelerometer for Testing Automobile Brakes[1]

By William S. James[2] *Illustrated with* Photographs and Chart

THE application of the brakes of a moving car results in a reduction of speed. The reduction in speed is obviously the result of a force opposite to the direction of motion. The *rate* at which the car slows down is directly proportional to the retarding force. If the car is moving at a speed of 20 m.p.h. when the brakes are applied, and the rate of slowing down is 10 m.p.h. in every second the car will come to a stop in 2 sec.; if it is slowing down at the rate of 5 m.p.h. per sec., it will stop in 4 sec. The retarding force in the first instance will have been twice that in the second. If the rate of slowing down remains constant the distance the car will travel before coming to rest will be the product of the time required to stop and the *average* speed of the car during this time. The average speed during the stop in the two cases mentioned will be 10 m.p.h., an initial speed of 20 m.p.h., a final speed of 0 m.p.h. and a linear change of speed with the time. As 10 m.p.h. is approximately 15 ft. per sec. the car will stop in 30 ft. in the first case and in 60 ft. in the second. It will be seen at once that the rate of slowing down is directly proportional and the distance required for a stop from a given speed is inversely proportional to the magnitude of the retarding force.

It is also known that the retarding force required to slow down a car weighing 4000 lb. at a given rate is twice that required to slow down at the same rate a car weighing 2000 lb. It is, therefore, obvious that to stop a 4000-lb. car in 30 ft. from 20 m.p.h. will require twice the force necessary to stop a 2000-lb. car in the same distance from the same initial speed. The retarding force *per pound or per* 1000 *lb. of car weight* is, however, the same with both the heavy and the light car, and results in identical stopping distances and rates of speed reduction. The above relations follow directly from Newton's second law of motion on the principle of the conservation of energy.

From the foregoing it will be seen that the effectiveness of automobile brakes can be measured directly by the braking force per unit of car weight, per pound, per 1000 lb. or per ton of car weight. The brake decelerometer designed at the Bureau of Standards is constructed in such a manner as to measure the braking force per unit of car weight. It consists essentially of a small bob-weight mounted at the upper end of a stiff flat spring. The spring is mounted vertically in the base of the instrument which is placed on the floor of the car so that the spring will deflect in the line of motion of the car. When a braking force is applied to the car a portion of this force is transmitted by the spring from the base of the instrument to the bob above it. This force is the same fraction of the total braking force as the mass of the suspended bob is of the total mass of the car. The force on the bob per unit of its weight is the same as the force on the car per unit of its weight. The spring is deflected an amount proportional to the force transmitted through it. The deflection of the spring is magnified by a lever system and calibrated by applying known forces per unit of weight of the bob and the instrument graduated in the desired units, pounds of force per 1000 lb. of car weight, rate of stopping in feet per

[1] Published by permission of the Director of the Bureau of Standards.

[2] M.S.A.E.—Physicist, Bureau of Standards, City of Washington.

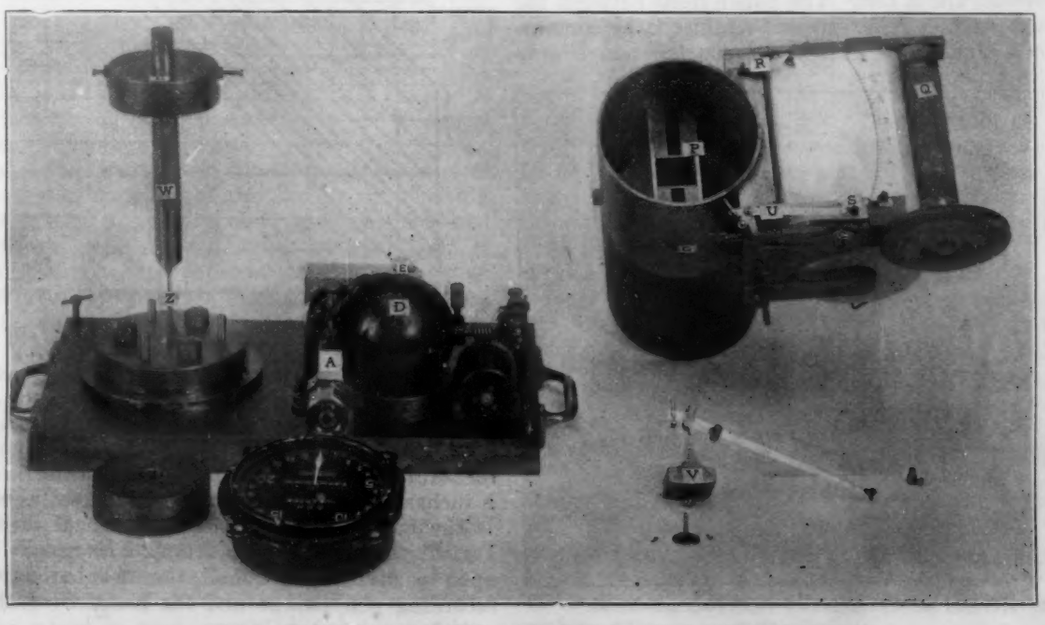


Fig 1.—The Bureau of Standards Decelerometer Disassembled

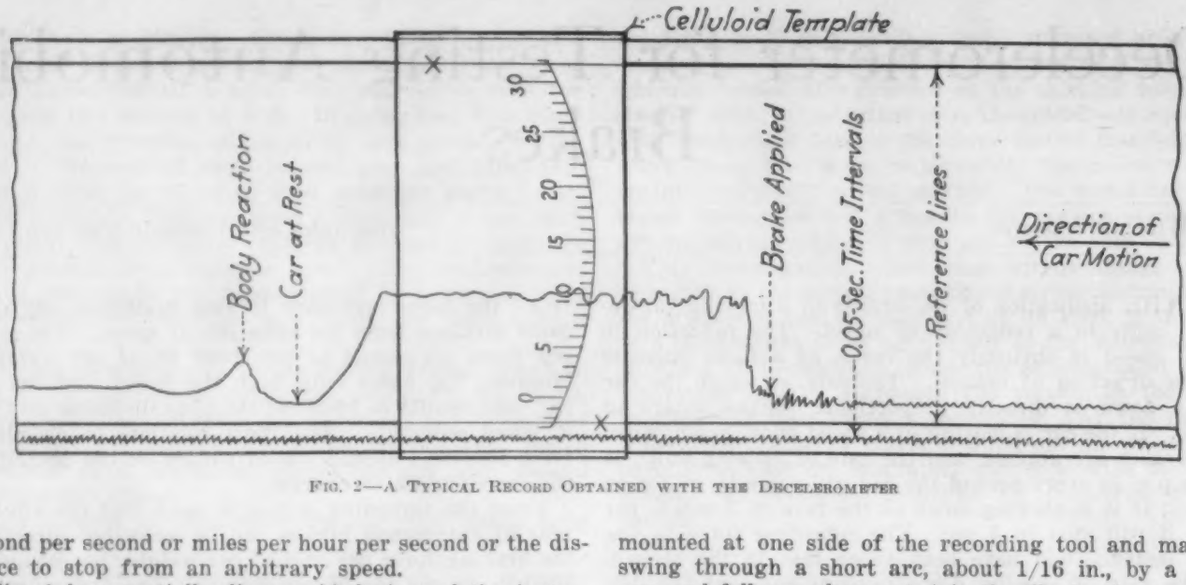


FIG. 2—A TYPICAL RECORD OBTAINED WITH THE DECELEROMETER

second per second or miles per hour per second or the distance to stop from an arbitrary speed.

Fig. 1 is a partially disassembled view of the instrument fitted with a recording attachment. The bob-weight *B* is supported above the stiff spring *Z*, which is rigidly mounted in the base-plate. When placed on the floor of a car the long axis of the base-plate is parallel to the line of motion of the car. The deflection of the spring *Z* is magnified by the stiff rod supporting the bob and the recording pen linkage *V*. The latter is supported by a cylindrical housing *G* that is screwed on the base-plate, and engages a short pin mounted on the end of the arm supporting the bob. The motion of the bob is damped by vanes *W* inserted in it and moving in oil-filled dashpots *P*.

The portion of the instrument just described is all that would be required for an indicating instrument. The recording mechanism was added for the purpose of a detailed study of brakes. By this means the deflections of the spring, as magnified by the multiplying system, are recorded on an unruled sheet of paper unwinding from a roll and drawn over a flat recording table by a 6-volt motor *D* that drives the roller *Q* through a worm and wormwheel and a belt. The paper feeds between the roller *Q* and an idler roller pressed against it by springs. To obtain a time scale on the records the pen *U* was mounted at one side of the recording tool and made to swing through a short arc, about 1/16 in., by a small cam and follower shown at *A* in the illustration mounted on the shaft of another 6-volt motor *E*. The motion of the cam-follower is transmitted to the pen *U* by a fine steel wire passing over the pulley *C*. The number of oscillations of the timing pen per second is obtained by a tachemeter driven from the shaft of the motor *E*.

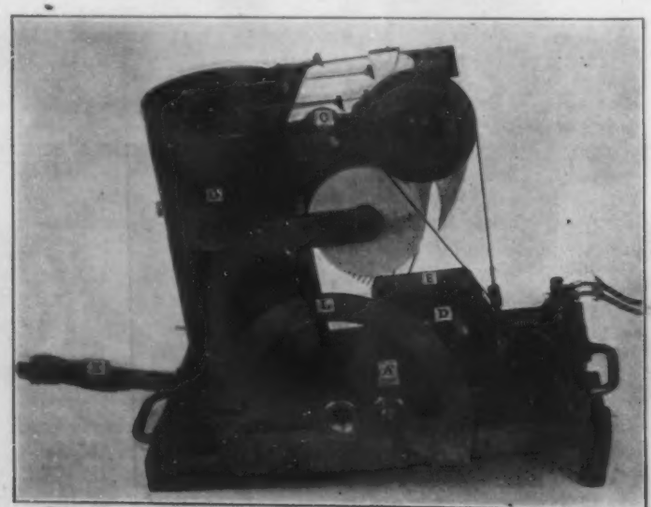


FIG. 3—METHOD OF CALIBRATING THE DECELEROMETER

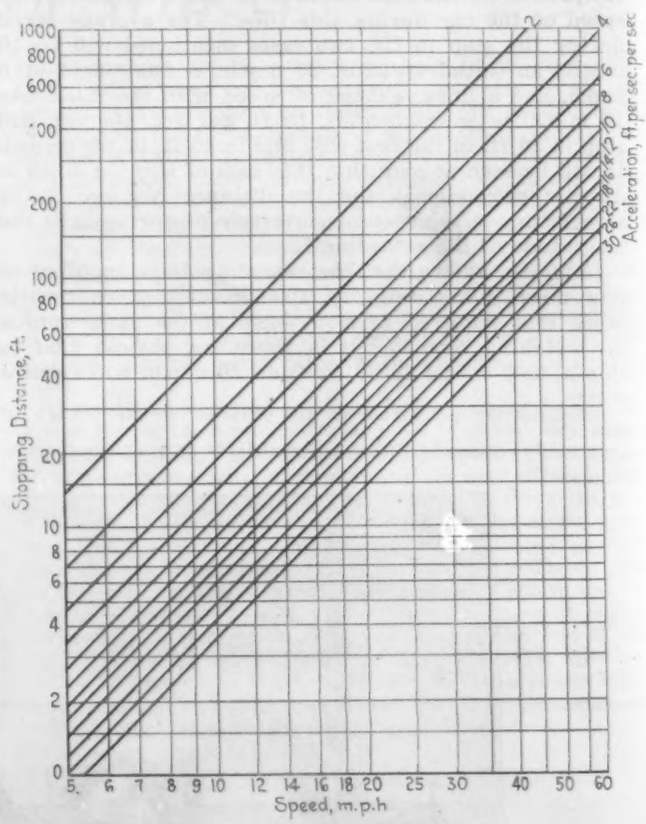


FIG. 4—CHART SHOWING THE RELATION BETWEEN THE STOPPING DISTANCE, THE INITIAL CAR-SPEED AND THE RATE OF DECELERATION

The method used to read the records is illustrated in Fig. 2. A transparent template is made by marking upon a piece of celluloid the arc through which the recording pen swings and the position of the two fixed

pens R and S shown in Fig. 1. These pens draw the reference lines as shown in Fig. 2 and the template is oriented on the record so as to bring their respective locations, as marked on the template by small crosses, over the lines drawn by the fixed pens. The intersection of the arc of the recording pen with the record gives the reading of the instrument in terms of the values marked upon the template. The graduations shown on the template in Fig. 2 are in feet per second per second. The time record is the wavy line near the edge of the paper and in this instance a swing of the timing pen occurred every 0.05 sec.

The method of calibration of the instrument is illustrated in Fig 3. A vernier protractor L fitted with a sensitive level bubble K is mounted on the base of the instrument. The instrument is first leveled and the protractor arm swung to a horizontal position as indicated by the level. The protractor is then read and the paper run for a few seconds to obtain the position of the recording pen with reference to the fixed pens. The instrument is then tilted through an angle, the protractor arm again leveled and the paper run for a few seconds. The protractor readings give the angle through which the instrument has been tilted and the records on the paper the corresponding position of the recording pen. The sine of the angle of tilt is the force applied to the weight in pounds per pound or if multiplied by 1000 the pounds per 1000 lb. of car weight. If the calibration is desired in feet per second per second, the value for any angle of tilt is obtained by multiplying the sine of the angle of tilt by the acceleration of gravity.

To obtain a record it is only necessary to press a button switch, thereby starting the paper-drive and timing-pen motors.

The relations between the distance required to stop s in feet, the initial car-speed v in miles per hour and (a) the rate of slowing down in feet per second per second a, (b) the rate of slowing down in miles per hour per second A, (c) the retarding force in pounds per pound F_1, (d) the retarding force in pounds per 1000 lb. of car weight F_2 and (e) the retarding force in pounds per ton of car weight F_3 are given in the following equations:

$$s = 1.08\, v^2/a \quad (1)$$
$$s = 0.735\, v^2/A \quad (2)$$
$$s = 0.0336\, v^2/F_1 \quad (3)$$
$$s = 33.6\, v^2/F_2 \quad (4)$$
$$s = 67.2\, v^2/F_3 \quad (5)$$

A plot of equation (1) is given in Fig. 4. Similar plots can be made to show graphically the other four relations.

If either rate of retardation or the retarding force per unit of car weight is known the distance within which a stop could be made if the initial speed were 20 m.p.h. can be found from the following relations which were obtained by substituting 20 m.p.h. for v in equations (1) to (5)

$$s = 432/a \quad (6)$$
$$s = 294/A \quad (7)$$
$$s = 13.44/F_1 \quad (8)$$
$$s = 13{,}440/F_2 \quad (9)$$
$$s = 26{,}880/F_3 \quad (10)$$

Judging from 250 records obtained with the recording decelerometer described, with about 35 different cars representing 22 different makes, of which the record shown in Fig. 2 is typical, it is believed that the rate of retardation or the retarding force per unit of car weight is sufficiently independent of the car speed to make the use of an indicating decelerometer practicable for the inspection of the condition of automobile brakes by the traffic authorities of large cities. A simple, rugged and portable decelerometer graduated to read in "feet to stop from 20 m.p.h." is now being built at the Bureau of Standards to illustrate further the practicability of this method for inspecting the condition of automobile brakes.

THE DIESEL ENGINE IN THE YACHTING FIELD

(*Concluded from p. 452*)

direction. Each problem is absolutely by itself and a general statement cannot be made.

CHAIRMAN L. C. HILL:—An interesting letter was received recently at the office of the Society complaining about a practice that the writer said had been followed in the motorboat trade for a number of years and is being followed today. He referred to the publication of inaccurate horsepower curves in motorboat magazines. Unfortunately, these curves are relied upon to design the lines of a ship and to select its propeller and its powerplant unit. It is often impossible in practice to come within 10 per cent of the horsepower curve anywhere throughout its length and in some cases it is necessary to rebuild the engine framing and re-design hulls that are three-quarters complete. Is not the publication of those curves bad practice?

MR. COLLEY:—I agree that the gentleman's complaint is justified, except that I think most naval architects have made it a point for the last 5 or 6 years to take from 10 to 15 per cent off the engine builder's curve and then suit the wheel to that condition to give a factor of safety for contingencies. As a matter of fact, our company makes it a practice to give figures about 10 to 15 per cent low. In most shops no two boats are alike and allowance must be made for weather conditions, skin-surface conditions and the various other things that affect the operation of a boat when it is placed in service.

L. G. NILSON:—At one meeting of the Society a number of years ago I suggested that we stop using the term "horsepower" and designate engines by their bore and stroke.

CHAIRMAN HILL:—I notice that the motorboat industry still continues to say that an engine is rated at a certain S. A. E. horsepower. There is no such thing as S. A. E. horsepower. The Society has no formula for horsepower and never has had one. The formula used was carried over from the old Association of Licensed Automobile Manufacturers' and at the time that organization went out of existence it was changed to the N. A. C. C. formula, taking its name from the National Automobile Chamber of Commerce.

TENTATIVE STANDARDIZATION WORK

Criticism of all tentative reports should be sent to the Standards Committee in care of the Society

AMERICAN STANDARDS NEEDED

Society Is Now Sponsor for Seven National Sectional Committees

With over 2000 technical societies and trade organizations in the country, of which it is known that at least 300 are working on standardization, it will be appreciated that standardization activities must be coordinated if a needless overlapping of standards shall not occur. This is of commercial as well as of technical importance, as conditions might confront a producer of a material in which a certain grade of his product would be acceptable in one industry and not in another, even though the real requirements of both should be identical.

To remedy this condition, *standards must be standardized.* To accomplish this, a correlating agency is necessary, a clearing house for standards. This clearing house has been realized in the American Engineering Standards Committee, an organization composed of representatives of 9 leading technical societies, 7 Governmental Departments and 19 trade organizations.

In carrying out its clearing-house functions, the American Engineering Standards Committee is restricted to insuring that all organizations interested, whether members of that body or not, are represented on the proper sectional committees. The sectional committees are generally organized by members of the American Engineering Standards Committee designated as sponsors. The sectional committee reports must be approved by the sponsors before they can be approved by the American Engineering Standards Committee as American Standards.

Since the Society became a member of the American Engineering Standards Committee in 1920, it has been designated as a joint sponsor for seven projects. The complete personnel of the sectional committees appointed for these seven projects represents 41 organizations. The accompanying chart illustrates the procedure that will be followed by the sectional committees in obtaining recognition of their reports as American Standards by approval of the respective sponsors and the American Engineering Standards Committee. In addition to the projects for which it is acting as a joint sponsor, the Society is represented on the following sectional committees, whose work will affect partially the automotive industry:

Code on Colors for Traffic Signals
Gears
Insulated Wire and Cables
Machine-Tool Safety Code
Methods of Testing Timber
Pipe Flanges and Fittings
Use, Care and Protection of Abrasive Wheels

WIRE CLOTH TO BE STANDARDIZED

Tentative Report Submitted to Wire Cloth Users and Manufacturers for Comment

Shipments of wire cloth direct from the manufacturers' stocks, quicker deliveries and an increase in the sources of supply are cited as probable results of the adoption in future practice of a proposal, submitted by E. W. Weaver, of the Parts and Fittings Division, to limit wire cloth for oil, gaso-

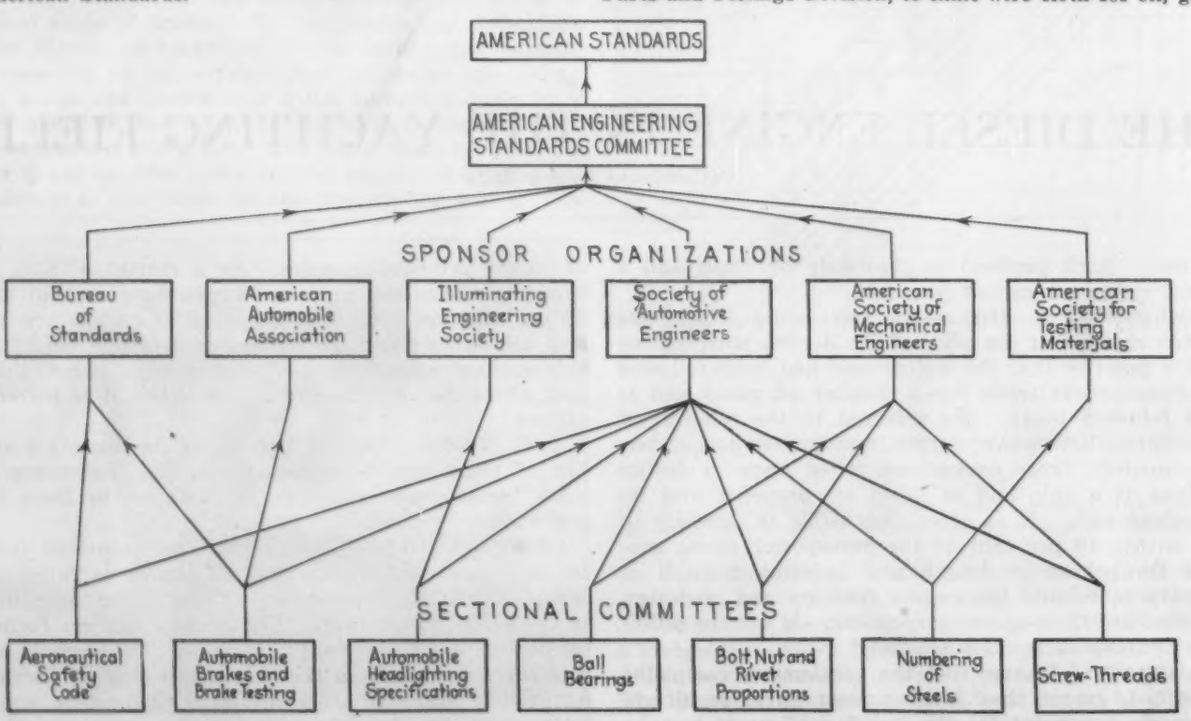


CHART SHOWING THE SECTIONAL COMMITTEES OF THE AMERICAN ENGINEERING STANDARDS COMMITTEE OF WHICH THE SOCIETY IS A MEMBER AND THE OTHER SPONSOR ORGANIZATIONS ASSOCIATED WITH IT ON THEM

line and water strainers to 10 meshes. The proposal, given in the accompanying table, has been sent to the engineering departments of passenger-car and motor-truck builders for comment. It is expected that it will be ready for Standards Committee action at the January meeting.

PROPOSED S. A. E. STANDARD FOR WIRE CLOTH

Mesh	Diameter of Wire, In.	Size of Opening, In.	Mesh	Diameter of Wire, In.	Size of Opening, In.
8	0.028	0.097	45	0.0095	0.0130
10	0.025	0.075	50	0.0090	0.0110
12	0.023	0.060	60	0.0080	0.0090
14	0.020	0.051	70	0.0070	0.0073
16	0.018	0.044	80	0.0060	0.0068
20	0.016	0.034	90	0.0050	0.0059
24	0.015	0.027	100	0.0040	0.0055
30	0.013	0.021	120	0.0040	0.0043
35	0.011	0.018	150	0.0030	0.0037
40	0.010	0.015	200	0.0023	0.0027

Mesh denotes the number of openings per inch.

Double-crimped wire shall be used and woven so as to make square openings.

The variation in the number of wires per inch shall not exceed 3 per cent. The variation in the diameter of the wire shall not exceed the following limits:

	In.
Up to and including 16 mesh	0.0030
From 20 to 50 mesh	0.0020
From 60 to 100 mesh	0.0010
Above 100 mesh	0.0005

The wire composition shall be definitely specified. Usual practice is to specify steel wire up to 16 mesh, brass wire from 20 to 100 mesh and phosphor-bronze or monel-metal wire above 100 mesh.

The weave shall be what is known as "plain," except that wire cloth in meshes 80 and finer may be "twilled."

STANDARD FRAME-WIDTHS SUGGESTED

Feasibility of Standardizing Motor-Truck Frames Open to Discussion

The Frames Division has been enjoying more than its share of differences of opinion since the standardization of motor-truck frames was undertaken early in the year. The recommendation now under consideration is given in the accompanying table, the side-rail thickness and the chemical composition having been omitted from the original proposal because of adverse criticism received, quotations from which are given below:

PROPOSED STANDARD FOR MOTOR TRUCK FRAMES

Truck Capacity, Tons	Frame Width, In.			Nominal Side-Rail Depth, In.	Actual Side-Rail Depth, In.
	Straight	Offset			
		Front	Rear		
Speed Wagons	32	....	....	5	4⅝
¾ to 1½	34	31	34	6	5½
2 to 2½	34	31	34	7	6½
3 to 3½	38	....	....	8	7½
Over 3½	38	....	....	9	8½

The classification of vehicles on a nominal basis of capacity rating for a structural standard of this type is entirely wrong and meaningless. Unless the Society wants to tackle the problem of defining the meaning of a 3-ton truck, the use of the term is certainly of no value from a technical standpoint. Commercial usage has destroyed whatever value such a method of rating has had.

With regard to the chemical composition, while it may be argued that frames are made for stiffness rather than for strength, and that for adequate stiffness plain carbon-steel is sufficient, there are some who take issue with that general principle as applied to motor-truck construction.

The suggestion to standardize the inside height of the frame by ½-in. increments is in order. It certainly is desirable to have frames of 5½ or 6-in. inside height, as this part of the frame die is invariably solid and may be used in connection with materials of various thicknesses. We have used a 4½-in. inside height of frame for approximately 10 years on light models, but the thickness of stock has been varied to suit the particular lengths required. This sort of standardization is the kind we should work on.

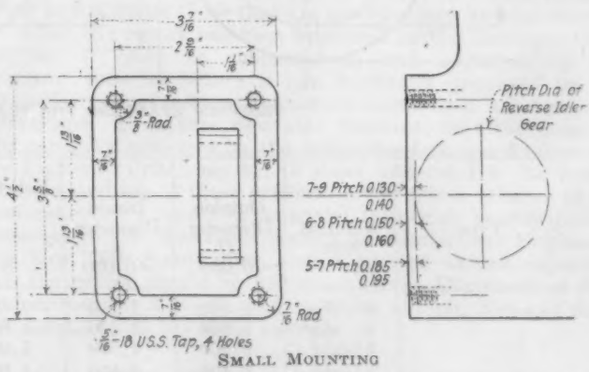
Builders of trucks should have the choice of thickness, which would not interfere with dies and give a better range of strength.

TIRE PUMPS INTERCHANGEABLE

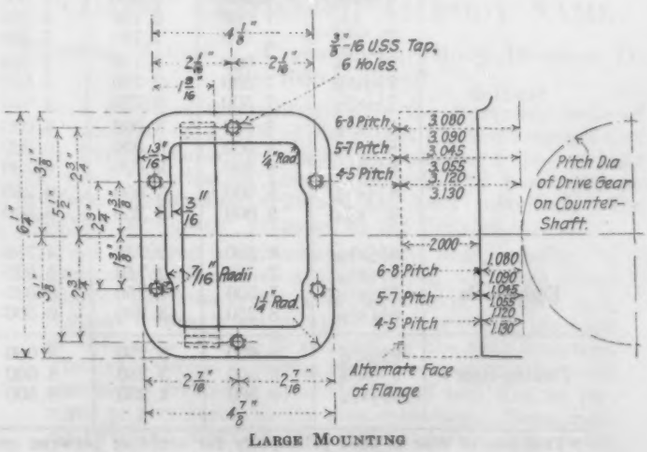
Transmission and Truck Makers Adopt S. A. E. Standard Transmission-Type Mountings

After the S. A. E. Standard for transmission-type tire-pump mountings was adopted in 1919, difficulty was experienced in designing transmission cases to accommodate various makes of tire-pump. In order to obtain complete interchangeability, the Transmission Division planned to extend the standard shown on p. E1 of the S. A. E. HANDBOOK to specify the largest space that the tire-pump should require, and appointed H. W. Sweet, of the Brown-Lipe Gear Co., to submit a recommendation based on the practice existing at that time.

At the October meeting of the Transmission Division Mr.



SMALL MOUNTING



LARGE MOUNTING

Sweet reported that installation difficulties have practically ceased during the last 2 years and that no need for further standardization now exists.

FLEXIBLE-DISC PROPOSAL CHANGED

Requirements of Over 175 Sizes Used in Present Practice Met by 21 Standard Sizes

On Oct. 18 the Subdivision on Flexible Discs held a meeting in Detroit at which the original proposal printed on p. 105 of the July, 1923, issue of THE JOURNAL was revised. On Oct. 19 the Parts and Fittings Division also held a meeting in Detroit at which the revised proposal, given in the accompanying table, was approved for adoption as S. A. E. Recommended Practice. During the Division meeting it was stated that if the recommendation were adopted in future practice, there would be a reduction from 175 to 21 in the number of sizes of disc used.

At the Subdivision meeting, which was attended by E. W. Templin and E. G. Kimmich, of the Goodyear Tire & Rubber Co.; A. P. Hamilton, of the Merchant & Evans Co.; J. W. B. Pearce, of the Spicer Mfg. Co.; C. A. Schell, of the Thermoid Rubber Co.; Ira S. Snead, of Snead & Co.; J. C. Sproull, of the B. F. Goodrich Co., and Standards Manager Burnett, revisions of the original proposal, based on the comments that had been received as a result of circularizing it among users and manufacturers, were made.

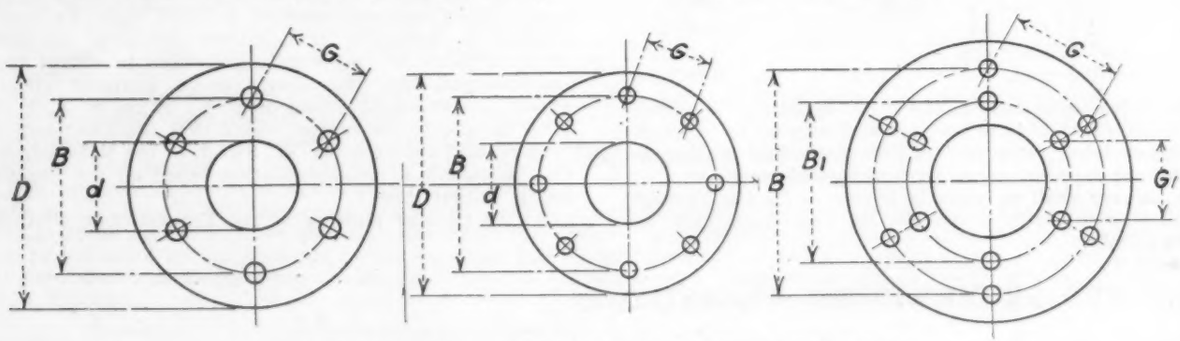
The consensus of opinion was against including the torque ratings because of the number of variables it is necessary to consider when selecting the proper disc for a given installation, such as the linear and angular positions through which the discs revolve, the type of service and the weather.

To aid the users, and to protect the manufacturers against the marketing of inferior discs, it was suggested that a standard minimum test for the material should be included. It was decided to give this matter further consideration.

The 6½ x 5/16, 7½ x 5/16, 7½ x 13/32 and 8¼ x 5/16-in. eight-hole discs were added to the proposal to meet the needs of a flexible drive-shaft coupling between the engine and the transmission.

The following changes and additions, based on the present practice of the large producers of automobiles, and on what is considered sound engineering, were made in the original Subdivision recommendation:

(1) The tolerances for the bolt-circle diameters were changed to plus and minus 0.010 in.
(2) The tolerances for the bolt-hole diameters were changed to plus 0.010 in. and minus 0.000
(3) The tolerances for the thickness were changed to plus 0.020 in. and minus 0.000.
(4) The 6 x ¼-in. size was omitted
(5) The inside and bolt-hole diameters for the 6½ x ¼-in. size were changed to 2.500 and 0.438 in. respectively
(6) The inside diameter was changed to 2.500 in. for the 6½ x 5/16-in. size



PROPOSED STANDARD FOR TRANSMISSION-TYPE FLEXIBLE DISCS

Type	Nominal Size	Outside Diameter *D* ±0.030	Inside Diameter *d* ±0.030	Bolt-Circle Diameter ± 0.010 *B*	Bolt-Circle Diameter ± 0.010 *B1*	*G* ±0.010	*G1* ±0.010	Bolt-Hole Diameter +0.010 —0.000	Thickness +0.020 —0.010
Six-Hole	6 x5/16	6.000	2.250	4.625	.....	2.313	.....	0.438	0.313
	6 x3/8[a]	6.000	2.250	4.625	.....	2.313	.....	0.500	0.375
	6½x¼	6.500	2.500	5.000	.....	2.500	.....	0.438	0.250
	6½x5/16	6.500	2.500	5.000	.....	2.500	.....	0.500	0.313
	7 x¼	7.000	2.750	5.250	.....	2.625	.....	0.500	0.250
	7 x5/16	7.000	2.750	5.250	.....	2.625	.....	0.500	0.313
	7 x3/8	7.000	2.750	5.250	.....	2.625	.....	0.500	0.375
	7½x5/16	7.500	2.750	5.625	.....	2.813	.....	0.500	0.313
	7½x3/8	7.500	2.750	5.625	.....	2.813	.....	0.500	0.375
	8 x5/16	8.000	3.000	6.000	.....	3.000	.....	0.625	0.313
	8 x3/8	8.000	3.000	6.000	.....	3.000	.....	0.625	0.375
	8½x5/16	8.500	3.000	6.250	.....	3.125	.....	0.625	0.313
	8½x3/8	8.500	3.000	6.250	.....	3.125	.....	0.625	0.375
	9 x3/8	9.000	3.250	6.500	.....	3.250	.....	0.625	0.375
Eight-Hole	6½x5/16	6.500	2.750	4.750	.....	1.818	.....	0.375	0.313
	7½x5/16	7.500	2.750	5.625	.....	2.153	.....	0.438	0.313
	7½x13/32	7.500	2.750	5.625	.....	2.153	.....	0.438	0.406
	8¼x5/16	8.250	3.000	6.500	.....	2.487	.....	0.500	0.313
Double-Row	9½x5/16	9.500	3.250	8.000	5.750	4.000	2.875	0.500	0.313
	9½x3/8	9.500	3.250	8.000	5.750	4.000	2.875	0.500	0.375
	10½x3/8	10.500	4.250	8.500	6.000	4.250	3.000	0.500	0.375

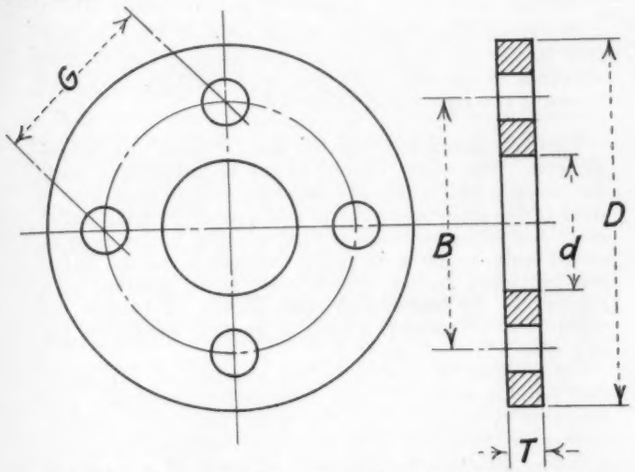
[a] This size of disc is used principally for coupling between engines and transmissions.
All dimensions in inches.

(7) The inside diameter was changed to 2.750 in. for the 7 x 5/16-in. size

(8) The following nominal sizes were added:

6 x 5/16	7 x 1/4	8 x 5/16
6 x 3/8	7 x 3/8	8½ x 5/16

As double-row discs of large diameter are used for severe service, it was considered advisable to include in the recommendation the 9½ x 5/16, 9½ x 3/8 and 10½ x 3/8-in. double-row discs.



PROPOSED STANDARD FOR GENERATOR AND MAGNETO TYPE FLEXIBLE DISC

Nominal Size	Outside Diameter *D* ±0.030	Inside Diameter *d* ±0.030	Bolt-Circle Diameter *B* ±0.010	*G* ±0.010	Bolt-Hole Diameter +0.010 −0.000	Thickness *T* +0.020 −0.010
2¾	2.750	1.000	1.875	1.326	0.328	0.250
3½	3.500	1.250	2.500	1.768	0.328	0.250
3½	3.500	1.250	2.500	1.768	0.328	0.313

To complete the proposal, it was recommended that smaller discs, used for generators and magneto drives, should be included. The disc dimensions shown in the accompanying table were suggested with the understanding that final action should be based on the comments of users and manufacturers.

PRESENT MOUNTINGS SUFFICIENT

Transmission Tire-Pump Mountings Satisfactory for Motorbus Generators

The Transmission Division has recommended that the present S. A. E. Standard for Transmission Tire-Pump Mountings shown on p. E1 of the S. A. E. HANDBOOK, shall be used for motorbus generator and starting-motor mountings. This action, based on the experience of several transmission makers, was taken in view of suggestions received by the Society to the effect that, because of the demand for motorbus generators of greater capacity than is needed in passenger-car engineering, and the lack of available space when mounted on the engine, special mountings should be standardized for motorbus applications.

BOLT-HEADS, NUTS AND WRENCH OPENINGS

Variations in Dimensions Analyzed and Tentative Recommendations Made

In March, 1922, the Sectional Committee for the Standardization of Bolt, Nut and Rivet Proportions was organized under the rules of procedure of the American Engineering Standards Committee by the American Society of Mechanical Engineers and the Society of Automotive Engineers acting as joint sponsors. A subcommittee, designated as No. 2, was appointed to report on wrench bolt-heads and nuts and, after obtaining and analyzing data covering practice in the United States and abroad, has submitted a tentative report for circularizing. Although the data in this report have been given some publicity, the subcommittee desires a careful review of them by all industries toward submitting whatever criticisms they may have to offer.

Included in the report is an analysis of the variations in dimensions for corresponding bolt sizes that exist generally throughout the industry in the United States, England and Germany. The recommendations in the report include dimensions of the heads, heavy nuts and jam nuts for rough and finished square and hexagonal bolts, finished light nuts, finished hexagonal and square cap-screws and their corresponding wrench openings.

The dimensions for the heavy and light nuts correspond to those used by some manufacturers in their present practice, but the subcommittee states that it has not been able to prepare tables of sizes that would meet the present practice of all industries, although the tendency in recent years has been toward more economical use of material for screws, bolts and nuts such as those made to the S.A.E. Standard. This part of the report is submitted particularly for consideration looking toward the use by all industries of a single standard for bolt-heads and nuts, using only light-nut dimensions for ⅝-in. bolts and smaller except that the width across flats of the 7/16-in. bolt be made 11/16 in. instead of ⅝ in. The tables of proposed dimensions, however, include the heavy nuts for the ⅝-in. size and smaller and the ⅝-in. width across flats for the 7/16-in. size.

The proposed tolerances are from basic to minus for all bolt-heads and nuts and from basic to plus for wrench openings to provide sufficient wrench fit clearance. The amounts of tolerance have been selected for "rough" and "finished" products, "rough" finish pertaining to stock made by cold or hot pressing, punching or forging, but not to semi-finished products made by any process. The "finished" class of products pertains to bolt-heads and nuts that are machined all over and includes those that are semi-finished by any process.

After the report has been approved by the Sectional Committee, it must be submitted to and approved by the sponsor societies before it can be finally approved by the American Engineering Standards Committee as American Standard. It is very desirable, however, that the proposal be carefully reviewed by the industries before a final report is drafted. Criticisms by all those interested in the manufacture and use of these products are solicited. Copies of the subcommittee's report in pamphlet form may be obtained on request to the American Society of Mechanical Engineers, 29 West 39th Street, New York City, and written comments on the report should be addressed to the Chairman of Subcommittee No. 2, Sectional Committee on Bolt, Nut and Rivet Proportions, at the same address.

"COACH" CRITICIZED AS BODY NAME

Recommendation of Passenger-Car Body Division To Be Reconsidered

As a result of the publication in the November issue of THE JOURNAL, on p. 417, of the report of the Passenger-Car Body Division covering "coach" as a standard type of body and its circularization among the body and passenger-car builders, considerable criticism has been submitted. The definition for "coach" proposed by the Division is

> An enclosed single-compartment body, similar in general appearance to a short sedan, with two close-coupled cross-seats for four passengers. There is a luggage compartment or space for a trunk at the back of the body. There is no glass in the rear quarters. The conventional type has two doors only, the forward seat being divided and the right-hand seat tipping forward to give access to the rear cross-seat. Some models have two doors on the right-hand side, there being two fixed cross-seats.

To obtain a definite idea as to the present practice of the car builders in naming this type of body, a careful survey of present practice was made. This survey indicated that the factories were, in addition to the standard coupe and sedan types of body, putting out two distinct types, one based on the coupe and the other on the sedan.

The type based on the coupe has a folding or tipping right-hand front seat, a full width rear cross-seat, two doors, two windows to a side, a luggage compartment at the rear and is constructed of metal above the belt-line. The names used by the various companies to designate this type of body, except for the minor differences listed in the footnotes, are given in the accompanying list:

BODY NAMES USED FOR THE FOUR OR FIVE-PASSENGER COUPE TYPE OF BODY DESCRIBED

Cadillac	Coupe
Chandler	Chummy Sedan
Cleveland	Two-Door Sedan
Dodge	Four-Passenger Coupe
Dort[1]	Brougham
Durant	Coach
Essex[2]	Coach
Flint	Four-Passenger Coupe
Ford[3]	Two-Door Sedan
Franklin	Brougham
Hudson[2]	Coach
Jewett	Brougham
Lincoln	Coupe
Maxwell	Coach
Nash Four	Carriole
Oakland	Five-Passenger Coupe
Olds	Brougham
Paige	Coupe-Brougham
Packard	Five-Passenger Coupe
Stearns	Coupe-Brougham
Stephens	Touring-Sedan
Studebaker	Coupe
Wills Sainte Claire	Brougham

[1] Has two doors on right-hand side.
[2] Fabric above belt-line.
[3] No rear luggage compartment.

The basic sedan type of body has two fixed cross-seats, four doors, windows in the rear quarters, a luggage compartment in the rear and is constructed of metal above the belt-line. With the exception of the luggage compartment in the rear, this type of body is actually a "close-coupled sedan." The names used for this body by the different companies producing it are given in the following list:

BODY NAMES USED FOR THE SEDAN TYPES OF BODY DESCRIBED

Cole	Bruette
Haynes	Brougham
Jordan	Four-Door Brougham
Marmon	Four-Passenger Sedan
Moon	Petite Sedan
Nash Six	Four-Passenger Coupe
Overland[4]	Champion
Reo	Brougham
Willys-Knight[5]	Coupe-Sedan

[4] Only three doors, no glass in the rear quarters and fabric above the belt-line.
[5] No glass in the rear quarters and fabric above the belt-line.

It will be noticed that about one-third of the names used are unpardonable misnomers. As an example, brougham, which seems to be as popular as any of the names, refers to a recognized standard type of body that is similar to the limousine except that the roof extends only over the portion of the body entirely enclosed.

The use of "coach" is more pardonable as it refers to an obsolete type of body, although the present motorbus might be considered to have rightly inherited that designation.

The comments that have been received in reference to the recommendation of the Passenger-Car Body Division have been referred to the Division members for consideration. Extracts of several are printed hereinafter as they will be found of special interest.

The name "coach" is very good for a two-door job, with the front seat tipping forward, but for a three-door job it should be called a four-passenger coupe.

Our recommendation is to use the term "close-coupled sedan" with two-three or four doors as the case might be.

We recommend that the coach type of body be limited to the two-door, four or five-passenger body with entrance to the rear cross-seat made possible by tilting forward the right-hand front seat.

I do not approve using the word "coach" as recommended. The word "coach" in the body-building trade has always had a definite meaning in the past and is used in the same way now in advertising by body builders. According to this practice, a coach is any type of closed body, coach-work being understood as the building of closed bodies, coach-work never having been applied to the building of open bodies. I believe the word "coach" should remain a general definition for any type of closed body.

On account of the unlimited number of variations that can be made of body construction to create different body types, I do not think that any positive results can be obtained by trying to standardize names to define different body types. In place of a standard name for closed bodies, I would prefer seeing the car builder use whatever name he wishes. He will do so anyway. Names to distinguish different models produced by the same builder could be effectively taken care of by using names similar to what are used on Pullman cars.

A coach is really not the name of a body at all, but refers to an entire vehicle. Moreover, the accepted definitions of the word are very broad and do not apply to any particular type of vehicle, although in the early coaching days it did have some reference to a type of vehicle driven with two span of horses in which passengers rode on top.

I personally do not think that the Society should sanction the standardization of a word that already has a very definite meaning in the English language and arbitrarily set thereto a new definition. I think we should encourage the development of new names for types of automobile bodies which would be characteristic and descriptive of the type of body in question.

The naming of bodies by various sales organizations has brought about a condition that is almost an endless task to unravel. As an example, I have been working on a close-coupled sedan type of body having two fixed cross-seats for five passengers equipped with four doors and with a deck on the rear for a trunk. It is the desire of the engineering department to call this a sedan type of body and describe it as close-coupled with two fixed cross-seats and equipped with four doors. The sales department insists on calling this a brougham, primarily on account of the fact that they feel that the general public would accept it as a brougham because the Jordan Motor Car Co. so defines it to the public at large.

It occurs to me that the engineers have a very serious problem on their hands in trying to educate the sales department as to the proper body nomenclature.

The term "coach" as now applied seems to refer to a cheaper type of body than built by the average company.

It appears to us that much more has been covered in the definition than the word "coach" implies. The

name indicates a two-door, enclosed, single-compartment body, with construction and appointments of a comparatively low grade; whereas, there exist two, three and four-door types of enclosed, single-compartment body, having high-grade construction and appointments throughout. To cover these types of body by the word "coach" appears very misleading to us.

The S.A.E. Body Nomenclature has really assumed definite shape and is forming a basis for a standard group of names that will at least be used by an important section of the industry and bodies so designated will be recognizable in advertisements or in technical writing without further explanation.

It is inexpedient to pervert the generic term "coach" to designate a single type of body, unless it be applied to the large motorized public-passenger vehicles that are being operated now in much the same manner as the former road or stage coach. Thirty years ago there was no doubt in the mind of any coach builder as to what was meant by a coach.

Now it is apparently intended that the term shall serve as a catch-all for the sundry modifications of the close-coupled body. Disregarding the matter of appropriateness, the proposed term fails to meet the requirement of utility if it will not be used, even after adoption by the Standards Committee. The name "coach" having been appropriated by an enterprising company and having come to be recognized as its particular appelation, who think that it will ever be accepted by the other car-builders as a group. Most companies building identical bodies have scoured the dictionaries and realms of fancy for a different name.

Practically none of the body names now in use represents the original concept of those names, but certain definite ideas have become instilled in the mind of the great motoring public of America. Regardless of the fact that coupe and sedan do not signify what these names originally did, motorists do recognize these two types. Why could not any of the miscellaneous group which it is proposed to list under "coach" be designated more clearly as coupes or sedans, modified according to the seating and door provisions? Thus, three-door sedan, if there are three doors and two cross seats. The two-door types may be designated as coupes, with the passenger-carrying capacity indicating readily the seating arrangement; the four-passenger coupe suggests immediately the staggered-seat job with an occasional seat folding into the cowl; the five-passenger coupe indicates a full cross-seat in the rear and two individual front seats. Is it not pretty close to selling a car "under false pretenses" to designate these bodies as "broughams" or "touring sedans" or some other classification to which the body is not entitled?

CARRIAGE-BOLT PRACTICE SIMPLIFIED

Sectional Committee on Bolt, Nut and Rivet Proportions Submits Report

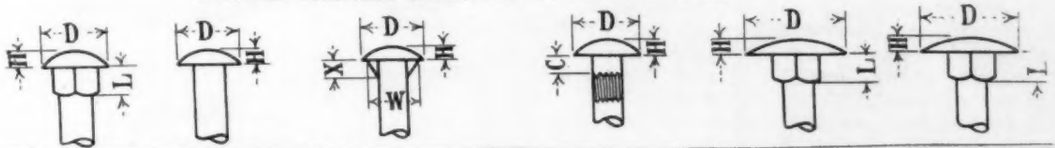
With the organization of the Sectional Committee on the Standardization of Bolt, Nut and Rivet Proportions, sponsored by the American Society of Mechanical Engineers and the Society of Automotive Engineers, the carriage-bolt standardization that had been undertaken by the Screw-Threads Division was referred to the Subcommittee No. 5 appointed by the Sectional Committee to consider the standardization of carriage bolts. The personnel of this subcommittee is:

E. Burdsall	Russell, Burdsall & Ward Bolt & Nut Co.
M. C. Horine	International Motor Co.
W. M. Horton	Kirk-Latty Mfg. Co.
R. Plumb	Buffalo Bolt Co.
C. B. Segner	Domestic Engine & Pump Co.
E. P. Stahl	Hyatt Roller Bearing Co.

The proposed standard, adopted by the Sectional Committee in January of this year, was based upon the dimensions and proportions of the various kinds of carriage-bolt used in current practice that were tabulated from data collected by the leading bolt manufacturers. The original Subcommittee report included dimensions for seat bolts, but these were eliminated by the Sectional Committee because the dimensions for the head were practically the same as for the step and the elevator bolts.

The dimensions included in the report were determined by definite formulas based on the body diameter. In addition to the dimensions given in the accompanying table, the Division recommends that the radius under the bolt head for diameters up to and including ½ in. should be 1/32 in. and for over ½-in. diameters, 1/16 in.; that the tolerances for the head for diameters up to and including ½ in. should be plus or minus 0.010 in., and for over ½-in. diameters, 0.015 in.; and that the angle of the counter-sunk head carriage-bolts should be 110 deg.

PROPOSED STANDARD DIMENSIONS FOR CARRIAGE BOLTS



Diameter of Bolt	Common Carriage			Button-Head Carriage		Fin-Neck Carriage				Ribbed Carriage			Elevator Bolt			Step Bolt		
	D	*H*	*L*	*D*	*H*	*D*	*H*	*X*	*W*	*D*	*H*	*C*	*D*	*H*	*L*	*D*	*H*	*L*
3/16	7/16	3/32	3/16	7/16	3/32	15/32	5/64	5/64	3/8	7/16	3/32	1/8	11/16	3/32	3/16	5/8	3/32	3/16
1/4	9/16	1/8	7/32	9/16	1/8	19/32	7/64	3/32	7/16	9/16	1/8	1/8	7/8	1/8	7/32	13/16	1/8	7/32
5/16	11/16	5/32	1/4	11/16	5/32	23/32	9/64	1/8	17/32	11/16	5/32	5/16	1 1/16	5/32	1/4	1	5/32	1/4
3/8	13/16	3/16	9/32	13/16	3/16	27/32	11/64	9/64	5/8	13/16	3/16	3/16	1 1/4	3/16	9/32	1 3/16	3/16	9/32
7/16	15/16	7/32	5/16	15/16	7/32	31/32	13/64	11/64	23/32	15/16	7/32	1/4	.....	.....	.....	1 3/8	7/32	5/16
1/2	1 1/16	1/4	11/32	1 1/16	1/4	1 3/32	15/64	3/16	13/16	1 1/16	1/4	1/4	.....	.....	.....	1 9/16	1/4	11/32
9/16	1 3/16	9/32	3/8	1 3/16	9/32	.....	.....	.....	.....	1 3/16	9/32	5/16	.....	.....	.....	.....	.....	.....
5/8	1 5/16	5/16	13/32	1 5/16	5/16	.....	.....	.....	.....	1 5/16	5/16	5/16	.....	.....	.....	.....	.....	.....
3/4	1 9/16	3/8	15/32	1 9/16	3/8	.....	.....	.....	.....	1 9/16	3/8	3/8	.....	.....	.....	.....	.....	.....
7/8	1 13/16	7/16	17/32	1 13/16	7/16	.....	.....	.....	.....	1 13/16	7/16	3/8	.....	.....	.....	.....	.....	.....
1	2 1/16	1/2	19/32	2 1/16	1/2	.....	.....	.....	.....	2 1/16	1/2	3/8	.....	.....	.....	.....	.....	.....

All dimensions in inches.

The report, which represents only a part of the work undertaken by the Sectional Committee on Bolt, Nut and Rivet Proportions, as might be inferred from its name, must be approved by the sponsors before it can be submitted to the American Engineering Standards Committee for approval as an American Standard.

COMPRESSION FITTINGS RECOMMENDED

Parts and Fittings Division Approves Original Subdivision Report as Revised

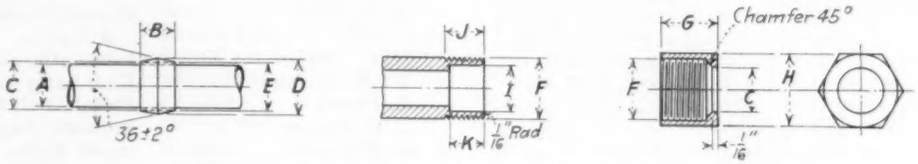
Agreement on the standardization of fuel and lubricating pipe fittings of the compression type, later confirmed by the Parts and Fittings Division, was reached at a special meeting of the Subdivision on Fuel and Lubrication Pipe Fittings, attended by W. H. Hollister, of the Imperial Brass Co.; W. J. Outcalt, of the General Motors Corporation; W. G. Wetherby, of the Ohio Metal Products Co.; C. S. Kellum and F. W. Borck, of the Commonwealth Brass Corporation; W. S. Chilman, of the McRae & Roberts Co., and C. A. Hill, of the Mueller Metals Co.

The recommendation, which is to be submitted to the Standards Committee for adoption as S. A. E. Recommended Practice, was developed by the subdivision consisting of W. H. Hollister and W. J. Outcalt. The original recommendation, published in the June, 1923, issue of THE JOURNAL, p. 581, was not acted on at the Standards Committee Meeting in June, however, because of the large number of criticisms received.

The recommendation is given in the accompanying tables. The revisions made in the original recommendation taken individually are of minor importance; but collectively they represent a careful refinement and a correlation of corresponding dimensions for similar parts.

SHEET STEEL COMMITTEES CONSOLIDATED

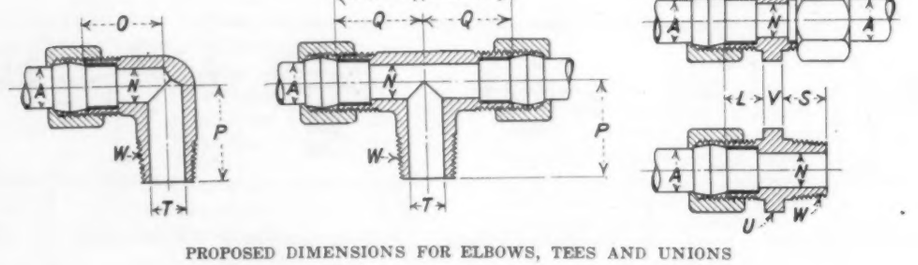
To coordinate the work of the American Society for Testing Materials and the Society of Automotive Engineers in the standardization of sheet steel, arrangements were com



PROPOSED DIMENSIONS FOR COLLARS, NUTS AND STRAIGHT THREADED-ENDS

Tubing Diameter *A*	*B*	Collar Bore *C*		*D*	Small Diameter of Taper *E*	*F*[1]	*G*	*H*	*I* ±0.002	*J* Minimum	*K*
		Maximum	Minimum								
1/8	3/16	0.130	0.126	3/16	0.140	5/16–24	11/32	3/8	0.136	1/4	3/16
3/16	7/32	0.195	0.191	17/64	0.205	3/8–24	3/8	7/16	0.196	9/32	7/32
1/4	1/4	0.259	0.255	11/32	0.269	7/16–24	13/32	1/2	0.261	5/16	1/4
5/16	9/32	0.325	0.321	13/32	0.335	1/2–24	7/16	9/16	0.328	11/32	9/32
3/8	5/16	0.388	0.384	15/32	0.398	9/16–24	15/32	5/8	0.391	3/8	5/16
1/2	3/8	0.517	0.513	19/32	0.527	11/16–20	5/8	13/16	0.531	7/16	3/8

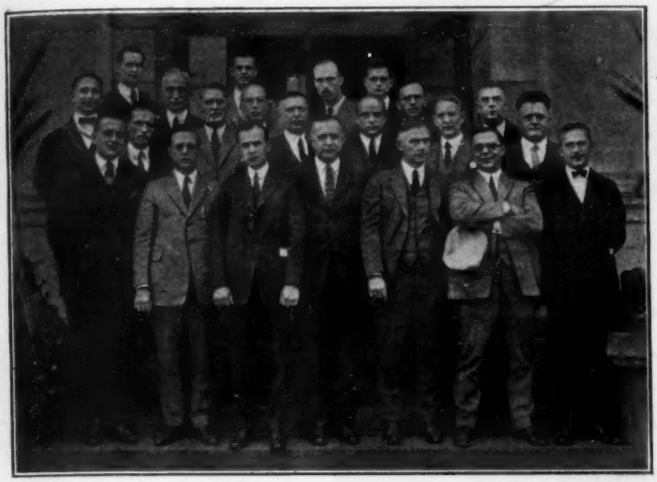
[1] U. S. Standard Thread.
All dimensions in inches.



PROPOSED DIMENSIONS FOR ELBOWS, TEES AND UNIONS

Tubing Diameter *A*	*L*	Diameter of Hexagon *M*	*N*	*O*	*P*	*Q*	*R*	*S*	*T*	Diameter of Hexagon *U*	*V*	*W*[2]
1/8	1/4	5/16	3/32	5/8	11/16	11/16	1 3/8	3/8	3/16	7/16	5/32	1/8
3/16	9/32	3/8	1/8	5/8	11/16	11/16	1 3/8	3/8	3/16	7/16	3/16	1/8
1/4	5/16	7/16	3/16	5/8	3/4	11/16	1 3/8	3/8	3/16	7/16	3/16	1/8
5/16	11/32	1/2	1/4	5/8	3/4	11/16	1 3/8	3/8	1/4	1/2	3/16	1/8
3/8	3/8	9/16	5/16	3/4	7/8	13/16	1 5/8	7/16	5/16	9/16	7/32	1/4
1/2	7/16	11/16	13/32	15/16	1 1/8	1	2	1/2	13/32	11/16	7/32	3/8

[2] Amercian Standard Pipe Thread.
All dimensions in inches.



THOSE WHO ATTENDED THE MEETING OF THE IRON AND STEEL DIVISION AT PITTSBURGH ON OCT. 12, 1923

pleted at the October meeting of the Iron and Steel Division held in Pittsburgh whereby the entire personnel of the Sheet Steel Subcommittee of the American Society for Testing Materials has been appointed on the Sheet Steel Subdivision of the Standards Committee of the Society. The personnel of the Subdivision as it now stands is:

W. C. Peterson, *Chairman*,	Formerly with the Atlas Steel Corporation
W. J. Beck	American Rolling Mill Co.
W. E. Cougherty	Allegheny Steel Co.
J. B. Dailey	General Motors Corporation
J. M. Darke	General Electric Co.
C. N. Dawe	Studebaker Corporation of America
F. C. Elder	American Steel & Wire Co.
F. Walter Guibert	Formerly with the Interstate Iron & Steel Co.
W. A. Irvin	American Sheet & Tin Plate Co.
G. T. Kelly	Edward G. Budd Mfg. Co.
J. H. Nead	American Rolling Mill Co.
F. E. McCleary	Dodge Bros.
E. W. Upham	Maxwell Motor Car Co.
J. M. Watson	Hupp Motor Car Co.
H. M. Williams	General Motors Research Corporation.

The members formerly on the Sheet Steel Subcommittee of the American Society for Testing Materials are Messrs. Beck, Cougherty, Dawe, Kelly and Williams.

AMERICAN LUMBER STANDARDS

Conference in the City of Washington on Dec. 12 to Act on Basic Report

One of the most important phases of the general standardization movements that have developed in the past few years is that of placing the lumber producing and consuming industries on a more economical basis in handling the product. At the first American Lumber Congress in 1919 steps were taken to inaugurate simplification in general standardization of lumber sizes and grades, the basic purpose being to demonstrate the ability and the purpose of the lumber industry to conduct its business efficiently and with due regard to the interests of the consumers. The Central Committee on Lumber Standards, representing the entire organized lumber trade from the producer to the consumer, was organized early in 1922 following a conference of lumber interests in the City of Washington. A consulting committee was also organized representing the same groups of interests to prepare, in behalf of their respective constituents, appropriate data for the consideration of the Central Committee. R. E. Brown of the Fisher Body Corporation represents the Society on the consulting committee.

William A. Durgin, chief of the Division of Simplified Practice of the Department of Commerce, has called a conference in the City of Washington on Dec. 12 at the request of Secretary Hoover of the Department of Commerce to take action on the recommendations for simplified sizes, nomenclature and trade practices presented in the Recommended American Lumber Standards as reported to the United States Department of Commerce by the Central Committee on Lumber Standards. The Society has been asked to appoint two or more representatives to be present.

The report includes sections dealing with

(1) Standard Lumber Classifications
(2) Standard Grade Names and Classifications
(3) Standard Yard Lumber Sizes
(4) Method of Lumber Measurement
(5) Standard Shipping Weights
(6) Shipping and Other Provisions

The specifications refer for the most part to yard lumber, structural timbers and shop or factory lumber but are of interest as probably being the basis on which standard dimensional or cutting-up sizes will be formulated for the automotive industries.

A report on the species, grades and dimensions of lumber purchased for automotive construction, principally bodies, is being prepared by the Forest Products Laboratories in collaboration with the Hardwood Lumber Standardization Subdivision of the Passenger-Car Body Division of the Standards Committee. It is expected that this report will be presented at the body session of the Society's Annual Meeting in Detroit next month.

WIKANDER SUBMITS FOREIGN PROPOSALS

Sectional Committee Acts on Report of International Conference in Zurich

Reference was made in the September issue of THE JOURNAL on p. 177 to a preliminary report received from Zurich, Switzerland, regarding the International Ball Bearing Standardization Conference that was held in that city on July 9. The detailed report agreed to at a conference in Berlin on Oct. 5, which is based on the report of the meeting in Zurich on July 9, has been received and referred to the Sectional Committee for Ball Bearings under the sponsorship of the American Society of Mechanical Engineers and the Society of Automotive Engineers. There are 10 proposals in all, the first five being definite and the others tentative. The first proposal is toward a definite agreement on outside diameters of ball bearings up to and including the 220-mm. bore in the light series, the 200-mm. bore in the medium series and the 190-mm. bore in the heavy series. The second proposal sets forth the widths for single row annular ball bearings up to and including the 140-mm. bore in the light series, the 120-mm. bore in the medium series and the 90-mm. bore in the heavy series. The third proposal refers to corner radii, the fourth to tolerances and the fifth to double row annular ball bearings. The sixth, seventh, eighth and ninth proposals supplement the first, second, third and fifth proposals respectively and refer to the dimensions for the extension of the series above those in the first proposal. The tenth proposal refers to metric thrust ball bearings.

The Sectional Committee, together with the Ball and Roller Bearings Division and Thrust Ball Bearing Subdivision of the Society's Standards Committee, at its meeting in New York City on Nov. 19 took definite action toward approving the first proposal only, inasmuch as the bearing dimensions included therein are the same as in the existing standards. It was felt, however, that the remaining nine proposals should be given further careful study before they are acted on and they were therefore referred back to the sponsor Societies for this purpose.

This project is practically the first one affecting the automotive industries on which a definite attempt has been made

toward international standardization and it is felt by the members of the committees working on it that there is very good promise of definite results, although there is still some question in their minds as to how far definite standardization should be attempted internationally. It is probable that revised proposals will be worked out and submitted to the foreign standardization committees before final action is taken by the sponsor Socities in this Country. Much progress has already been made toward better agreement between the several countries as to what the international standards shall be and it is possible that such agreement may be had sooner than was expected.

Much was accomplished by O. R. Wikander, chairman of the Sectional Committee's Subcommittee on Information, who, during his extended trip abroad, was able to confer with the national committees, particularly in Great Britain, Germany and Sweden, and was largely instrumental in bringing about the conference in Zurich last July. He presented considerable first-hand information regarding conditions abroad and the desires of the foreign ball bearing manufacturers relating to the program of standardization that might not otherwise have been available to the Sectional Committee and sponsors if the work had been carried on entirely by correspondence.

RESEARCH AN IMPORTANT FACTOR IN HIGHWAY IMPROVEMENT

(*Concluded from p.* 496)

taken; while the latter should determine the probable amount and character of the future traffic that will use a given highway during the lives of its several component parts.

In connection with the proper allocation of funds for highway construction, it was pointed out that the engineer in charge should base his decision upon considerations of the requirements of the State as a whole, and furthermore that he should visualize potential as well as present needs.

Mr. Hamlin outlined the general conditions for successfully carrying through traffic surveys, mentioned costs of various items and gave examples of past experience. These included a tabulation of surveys.

Motor-Truck Transportation in New England

Correlating motor trucking facilities with those of other transportation systems forms one of the most important factors in the effective handling of freight and passengers. J. G. McKay, of the Bureau of Public Roads, in his report for the committee on highway traffic analysis, gave a statistical treatment of truck transportation as carried by 240 companies operating in the principal New England cities. Of over the 1,000,000 net tons of freight hauled over the Connecticut highway system between September and December, 1922, about 67 per cent was hauled less than 30 miles.

Road Maintenance

The combination of truck and rail, truck and boat and truck, rail and boat services were said to be growing in importance very rapidly. Cooperative arrangements between the operating companies seem to be yielding highly satisfactory results and promise to expedite very greatly terminal freight movement, decrease the volume of freight warehoused, reduce the cost of moving freight through terminals and make the rail delivery time of freight in less-than-carload lots more rapid.

Chairman W. H. Root of the committee on maintenance reported that seven problems were studied during the year and that the outstanding conclusions of the investigations were as follows: corrugations in gravel roads result from excessive traffic and are in no way dependent upon construction or maintenance methods; mulch should be applied in very light courses, preferably late in the season or during the spring, and should not exceed 1 in. in depth; the demand for a light-colored crack-filler has decreased to such an extent that further search is unnecessary; snow removal equipment should be developed that is especially adapted to highway work; guide, caution and danger signs should be standardized to facilitate intercounty and interstate traffic; a uniform system of maintenance accounts would put the maintenance reports on a comparable basis; constantly increasing traffic makes it almost impossible to determine accurately the effect of age on the maintenance costs of highways and the subject is worthy of further and very careful consideration.

Highway Construction Costs

H. H. Wilson, representing the Associated General Contractors of America, stated that the activities and interests of that organization in cooperative work with the Advisory Board are largely confined to investigations upon the items that affect the cost of construction or the business end of construction and designing. He mentioned the following general divisions of the work and reported progress in the consideration of each of them: material supplies; field work force; methods; equipment development; seasonal suspension of work; removable hazards of the industry; and comparative statistical relations.

At the conclusion of the session brief reports were presented from the floor by representatives of the several organizations cooperating with the Advisory Board in research work.

MEETINGS OF THE SOCIETY

AIR TRANSPORT MUST PAY DIVIDENDS

Only Basis on Which Aviation Can Prosper, W. B. Stout Tells Detroit Section

W. B. Stout

Commercial aviation must be made profitable financially if we are to have a stabilized aeronautical industry in this Country. Until an industry can take its place on the basis of earning capacity, it can never be a true success, no matter how many millions of dollars in Government appropriations may be spent in its support. No industry can be classed as permanent that keeps its books in red ink. To make aviation pay dividends, then, is the fundamental problem that must be solved before an American aeronautical industry, in the true sense of that word can exist. These are opinions expressed by W. B. Stout in his illustrated talk before the Detroit Section, Nov. 1.

Commercial aviation must be built upon conditions as they are. It is all very well to dream of days when landing-fields will be plentiful and airplanes will be produced economically in great quantities, but the promoters of tomorrow's commercial aviation must face conditions as they exist and make profits from them. This fundamental must be kept in mind when discussing the probability of establishing the aeronautical industry on a sound basis, according to Mr. Stout.

Just as the development of the automobile itself has carried forward the expansion of the automobile industry, so the future of air transportation depends upon the development of the airship and the airplane. An analogous case is that of motorbus transportation. Long ago it was recognized that urban and interurban transportation of passengers by motorbuses was the coming method, but the motorbus business did not thrive until one organization produced a bus designed especially to operate profitably in this service. Once this was done, motorbus lines sprang up all over the United States and the bus industry became an established fact.

Must Carry Greater Pay-Load with Same Power

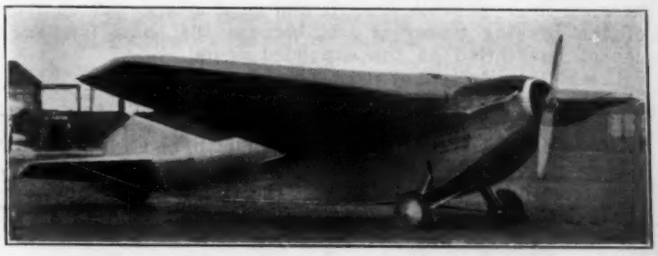
Before airplanes can be expected to pay dividends, they must be designed to carry more pay-load with the engine powers available today. This does not mean that larger planes must be built. If an airplane is doubled in size, its wing area, which represents its lifting ability, is increased only four times but its volume or weight will increase nearer eight times. Lighter-than-air ships, on the other hand, profit from an increase in dimensions. If an airship is doubled in size, its envelope or surface is multiplied four times, but its volume, which represents its lifting capacity, is increased eight times. This is a fundamental difference between the two mediums of air transportation and one that will result in the construction of large airships as opposed to relatively small airplanes.

Safety is the first element in commercial aviation that concerns the average man. Certainly it is the matter of first importance in the mind of the banker or investor who will be called upon to finance the development of air transport. Yet comparatively few people realize that the United States Air Mail is operating over 95 per cent of the days in the year between New York and San Francisco without any serious accidents. The Central Division between Chicago and Salt Lake City recently finished its 106th week of 100 per cent performance on that section. That completes nearly 2 years of service without a forced landing, the planes flying every day and operating on a definite time schedule. Mr. Stout cited this as an example of what can be accomplished by properly organized commercial aviation from the standpoint of safety and regularity.

Inexpensive Construction of Paramount Importance

Mr. Stout emphasized the fact that the commercial airplane of today must be designed so that it can be built cheaply. He distinguished between building and manufacturing, saying that airplanes cannot be manufactured and sold in large numbers at present but must be built along small production lines, just as motorboats are built. For this reason, the present-day commercial airplane must be a very simple structure, built up with the least expensive methods of construction. It must be able to operate the greatest number of hours in the air and spend the least number of hours on the ground. War planes are not adapted to commercial service because they require an excessive amount of repair and maintenance work. Mr. Stout believes that the commercial airplane of the future must be capable of flying 20 hr. per day because there will be more night than day flying. He reported the Air Mail pilots, who flew the night schedules during the late summer, as being more favorable to night flying than to day flying.

Slides were shown of the early types of airplane, including the Wright, Farman, Bleriot and Latham, to illustrate the development of the present-day type of internally-trussed monoplane that Mr. Stout favors. He ended his talk by taking some 60 members to visit his factory where they were shown two metal monoplanes of this design. The one illustrated on this page was in completed condition. It has a wing spread of 40 ft., weighs the same as a small sedan, 1850 lb., and is powered with a 150-hp. engine. Construction of the thick-section monoplane wings from rolled duralumin, formed to give maximum strength and stiffness with minimum weight, has resulted in a structure that weighs only 1.1 lb. per sq. ft. of wing surface. This compares with 1.6 lb. per sq. ft. in the case of the all-metal German Junker monoplane and 2.8 lb. per sq. ft. for the Fokker monoplane that flew from New York to San Diego without stop.



Stout All-Metal Air Sedan

A second and larger airplane was shown in process of construction. This new one will be powered with a Liberty 400-hp. engine and will carry a load of 1 ton at a speed of 110 m.p.h.

FOUR-WHEEL BRAKES PLEASE USERS

C. W. Jacobs Analyzes the Various Designs at Minneapolis Meeting

C. W. JACOBS

Improvement in brake action is imperative to take care of congested city traffic and fuel-eating country hills, according to C. W. Jacobs, service manager of the Pence Automobile Co., Minneapolis. At the Nov. 7 meeting of the Minneapolis Section, Mr. Jacobs presented four-wheel brakes as the best solution of the problem. His paper, An Analysis of Various Four-Wheel Brake Designs, was illustrated by the use of a front-axle brake assembly.

Mr. Jacobs began his analysis by pointing out that mechanically the problem of four-wheel brake installation has been successfully solved, and the only criticism that can be made of it is from a sales point of view.

INTERNAL AND EXTERNAL BRAKES CONTRASTED

The first layout discussed was the internal expanding system. This arrangement necessitates fewer operating parts and is possibly the neatest looking of any of the present designs. Theoretically, the brake-bands or shoes are protected from all adverse road and weather conditions, but this is not wholly true in practice.

To eliminate all water, sand and dust from the inside of the drum is impossible and the more closely fitting the protecting shields are made, the harder it is to throw out the small particles of grit that do gain entrance to the interior of the brakes, and frequently the operating pins on internal brakes are found to be badly rusted because of their inaccessibility and consequent lack of lubrication. If drain holes are included in this design they must be small enough so that they do not act as inlets for dirt and moisture, and if small they soon become plugged with dirt from the road and so lose any usefulness they may have originally had.

Undoubtedly the braking pressure of the internal brake can be made as effective as the external, but working on a smaller area than the external, given the same size drum, and without the wrapping effect of the external, it demands greater braking effort on the part of the operator or longer braking leverages.

The heating of internal brakes has a marked effect upon them if applied severely on long grades. It is surprising to note the actual additional movement of the brake pedal on some internal brake designs and what a large percentage of the braking power is lost because the same leverage cannot be exerted on the expanded drum.

Complete protection of front-wheel brakes seems altogether unnecessary, as external rear-wheel brakes on almost every make of car have for years been subjected to mud, sand, rain and snow without any serious handicap, and the application of this type of brake to the front wheels does not subject it to any worse conditions at the front end than it has at the rear. In fact, the perfect freedom these brakes have for throwing out any particles that do lodge between the drum and the lining tends to keep them clean as far as the braking surface is concerned.

Thermal expansion increases rather than decreases the braking ability of the external brake because as the drum expands it swells toward instead of away from the bands.

Like anything else on an automobile that is to prove mechanically sound, four-wheel brakes must be designed for and built into the particular car on which they are going to operate and not merely attached as an after-thought.

ANCHOR BLOCK IMPROVES EXTERNAL BRAKING POWER

Discussing the flexible brake-band, Mr. Jacobs pointed out that it cannot be used with impunity on the internal design, although it is ideal for external use. If the band anchor block is placed so that a long portion of the band can be used for forward braking, with the short portion for backward braking, a wrapping effect can be produced on forward braking that is similar in action to a half hitch with a rope, and tremendous braking power is produced at the wheel with comparatively little pedal pressure.

This design is fully permissible with four-wheel brakes where possibly it is not with two-wheel brakes. For example, a brake-band designed alike on all four wheels, with a three-quarter lapping for forward braking and a quarter lapping for backward braking, gives four quarter-laps for backward braking, which is equal to the two half-laps of the conventional two-wheel system. But it has increased the forward braking ability by four three-quarter-laps, instead of the possible four half-laps. This is an increase in braking area of 50 per cent over the four-wheel braking system using half-laps, and an increase of 150 per cent over the conventional rear-wheel brakes.

These results are brought about because the greatest braking power is produced by that portion of the band which is behind the anchor block and in the direction of rotation of the wheel, while that portion of the band which is ahead of the anchor block in the direction of rotation is not exerting its full ability because it is being lifted off the drum instead of being wrapped around it.

If this long portion of the band has one or two intermediate points of adjustment, it then allows four or five places to adjust on each wheel which permits an accurate, well-fitted band that, because of its flexibility, will give a full contact on every brake application besides eliminating the necessity for a fully equalized layout.

UNEQUALIZED DESIGNS MORE PRACTICAL

With reference to the equalized system, the speaker reminded his audience that complete or perfect equalization of four or even of two brakes is almost impossible to achieve in actual practice, because of the difficulty of keeping every part, pin and bearing working with the same freedom of drag or friction. When one part of the mechanism fails to work as freely as all the other parts, equalization is entirely upset and the equalizing bars or shafts function in theory only. In an equalized system the danger exists that, if one part of the operating mechanism fails, the entire braking system is made inoperative, because no place remains at which to get a foothold to exert leverage on the rest of the layout.

In the case of an unequalized design, the adjustment of each brake must be exactly similar to that of all the others and this requires a close and accurate adjustment of all four. Tests have shown that these adjustments can be maintained for remarkably long periods of time without attention. This design possesses an inherent safety because some part on each brake would have to fail before entire braking power would be lost.

FUTURE BRAKES PROBABLY HYDRAULIC

The hydraulic method of brake application is by far the neatest looking of any yet designed, is capable of being made to exert tremendous pressure and, for equalization of braking pressures, approaches a point of perfection. Mr. Jacobs made the point that, as in all equalized types, a failure of one pipe makes the entire system inoperative. Unlike other equalized types, however, the hydraulic method can be designed for the differential action of the front brakes by by-passing a certain amount of oil when the

wheels are turned and thus reduce the braking pressure on the outside wheel. This method of applying brake pressure is, however, subject to weather conditions and care must be taken to keep the viscosity of the fluid high enough to operate satisfactorily with all temperature changes. The operating fluid is usually some mixture of glycerine and oil in varying proportions. Water is never used because of the possibility of rusting and freezing.

Although the advantages of the present hydraulic systems must be discounted somewhat because of the extreme care necessary to maintain them in perfect operation and the difficulty in getting them serviced, Mr. Jacobs believes that a development of the hydraulic idea will probably be the leading method of brake application in the future.

Mr. Jacobs concluded his interesting analysis with the statement that altogether four-wheel brakes are one of the finest developments ever added to the automobile and that, in his opinion, not one sensible, logical, reasonable argument can be used against their universal adoption.

Questioned about trouble due to dragging of the band on an external brake, Mr. Jacobs replied that such trouble is likely to occur if the anchor block is not used. With the anchor block, the spring control is always pulling the spring band away from the drum.

With half-laps on the average set of brakes, in almost all cases, the lining of the upper half, if properly adjusted, wears out more quickly than the lower half; but, as Mr. Jacobs pointed out, the lower half, that is, the brake nearer the front end, wears first.

The user's experience is a valuable guide. The increased braking ability and surer control of cars equipped with four-wheel brakes has been found to be appreciated by their drivers. A test made on Michigan Avenue, Chicago, showed that the car with four-wheel brakes can make more headway than the car with brakes on only two wheels. While the other cars were going a block, the test car went a block and a half without more danger of accidents and complying with all the traffic rules.

The next meeting of the Minneapolis Section will be held at 8 o'clock on the evening of Dec. 5, in the Manufacturers Club room, Builders Exchange, Second Avenue, South, between Sixth and Seventh Streets, Minneapolis.

GATHERING OF THE AERONAUTIC CLAN

Spirited and Valuable Discussion Before Metropolitan Section

E. P. WARNER

The most representative meeting of aeronautic engineers for at least 3 years discussed the present status and prospect of aircraft, with reference to the operation of civilian air-routes and of non-Governmental individual craft. Several members traveled long distances to hear Prof. E. P. Warner, the Society's vice-president for aviation and associate professor of aeronautical engineering at the Massachusetts Institute of Technology, discuss Civil Aviation in 1923. In addition to the paper that had been prepared in advance of the meeting, he spoke extemporaneously at some length, one of his major premises being that all figures which have been collated indicate that the special hazard of air transport resides primarily in poor maintenance, poor piloting or poor airplane design and not in the inherent nature of flight. The accidents in the Air Mail Service are so few that they can be deemed virtually non-existent, although that service operates under conditions that would be considered impossible for any passenger-carrying air-line in the world. In England there has been only one accident involving serious injury to a passenger on any commercial line in the last 2½ years, during which time nearly 5,000,000 passenger-miles have been flown. A Dutch company has covered very nearly 1,000,000 airplane miles without a serious accident, and at least one French line has a perfectly clean record. The crux of Professor Warner's argument was that to gain public confidence the airplane must be operated on a large scale for a considerable period of time. The difficulty is to enlist a sufficiently large amount of capital to support such an undertaking. There is very little travel relatively by air today and there will not be much more in his opinion so long as the public idea of an air-line consists of a small airplane traveling each day on each of three or four routes in the Country. The maintenance of ground engineering and mechanical staffs at a few fields for the purpose of welcoming a few airplanes each day is outside the realm of practical business procedure. Professor Warner thought that as a general thing the granting of subsidies to airplanes, which is common practice in Europe, will not be helpful in the long run. The Government should extend assistance in this Country by providing ground organization facilities and in similar ways. The establishment of landing-fields is obviously a Governmental function. The Air Mail Service, which has an unequaled record, should be extended by Governmental operation and also through contracts with civilians. The greatest contribution to aeronautics during the last 3 years has been that of the Air Mail Service, including, of course, transcontinental flight by day and by night.

Professor Warner said that no greater number of passengers are carried by aircraft in Europe today than were carried 2 years ago. He believes that the relatively high cost of travel is not an impediment. In fact, considering the depreciation of European currency, air travel is in some cases cheaper than rail travel. The supposed danger is what keeps the public from flying. Statistics are not enough to obviate this, direct contact with large-scale flying being necessary. The speaker deplored the fact that the principal things the public reads about aircraft is stories of great altitude and very fast flights. He stigmatized aircraft stunting and acrobatics as the curse of commercial use of aircraft. One thing that makes flights of the Shenandoah effective is the fact that she cannot be stunted.

Alexander Klemin in a written communication advocated establishing mail and express service before concentrating upon the expansion of passenger service.

W. B. Stout in a breezy letter stated that aviation must "go out and get" for itself. No aircraft enterprise is profitable now, the present airplanes not being suitable. A commercial plane must be developed. The enactment of regulations will not develop aviation. Machines must be able to operate from 6 to 20 hr. per day and have marked ability to fly, climb and carry freight. The way must be paved with present conditions recognized and accepted. A sizable portion of the public is now willing to pay to fly.

R. H. Upson advocated "making haste slowly." The public must be given time to accept aircraft in a wholehearted way. In the meantime, much progress can be made by improving aircraft as well as securing thoroughly reliable engines therefor. Flying must be maintained consistently at night. The future of aviation is in the hands of a few adventurous spirits, and commercial flying will come with a rush when it does come.

C. F. Redden concurred in the view that what will establish aviation is confidence. Thoroughly well-maintained flights over established routes alone will serve the purpose. The perfect aircraft will not arrive in any shorter time relatively than did the present highly-developed automobile. Aircraft will be developed by the operating organizations and men. The flying-boats maintained by the company with which Mr. Redden is associated have traversed the water between Cleveland and Detroit 500 times, carrying 4000 passengers, without trouble. Mr. Redden believes that at no time during the operations of this company would its

business have been increased much by reducing the price of flights to passengers. He is firmly of the opinion that the prime requisite in the maintenance of civilian air-routes is organizations, and that as a result of their work the aircraft will be improved in construction. In the service that has been maintained by the company for over 3 years, more than 1,000,000 passenger-miles have been flown, over 30,000 persons having been carried, with only 1 serious accident. Mr. Redden believes that a successful operating company can be organized anywhere in this Country today, flying having been proved to be safe. He feels that there is no doubt as to the desire of the public to fly.

Augustus Post urged the necessity for establishing additional landing-fields. He mentioned briefly a considerable volume of freight carried by air in Europe, this being necessary to maintain business in the articles in question. He is of the opinion that business cannot continue much longer to deny itself the advantages of aviation. The telegraphic service would not be abolished today. He referred to the airship as the most suitable medium for long flights like those across oceans.

Grover C. Loening mentioned successful flying that has been done for more than 3 years by individuals, the reason for this being the time saved. He said that 120 privately owned airplanes were flown to St. Louis from various parts of the Country at the time of the Air Meet there. He averred that there are not that many civilian airplanes in Europe. The St. Louis demonstration is an excellent example of what can be done after a proper start is made. Mr. Loening spoke of the limitations placed upon the dirigible by weather conditions but declared that the feasibility of traveling by airplane 120 m.p.h. for 1000 miles is a salable thing today.

R. B. C. Noorduyn, in mentioning the European subsidies, said that some of these are limited to two-thirds of the loss of operating companies and that some of the subsidy payments have resulted in good engineering development. He recommended that muffler experts devote their attention to aircraft, as the noise of aircraft causes some of the fear of them. With regard to staying in the air 20 hr. per day, the only thing that prevents this is the necessity of changing engines. He did not agree with Mr. Redden that organizations and not airplanes make air-lines. It is a matter of the craft to a large extent. Nothing but fog will stop the flight of an airplane today.

M. L. Paterson referred to ballooning done at night in 1835, and also to the extensive aircraft flying done during the war practically without lighting equipment. Mr. Paterson was associated with the company that was intimately connected with the development of the beacons that were used to light the route from Chicago to Cheyenne during the time of the Air Mail night flights. There are three classes of these beacons: 36-in. arc searchlight of 450,000,000 cp., 18-in. incandescent and acetylene lights. There are, of course, various phases of illumination for night flying, including landing lights on planes and boundary lines for fields.

Chairman Cornelius T. Myers' conclusion, as a layman so far as aeronautics is concerned, was that in that art everyone is making progress and everyone is helping everyone else.

At the close of the meeting films were shown by the Aeromarine Company of flights of seaplanes and by the War Department of its latest dreadnaught bombing tests.

MANUFACTURING MORE QUIET GEARING

Detroit Section Production Meeting Produces Very Valuable Discussion

Gear noise and production methods for combating it were the topics discussed at the Detroit Section's first monthly production meeting on Nov. 15. This meeting can be recorded truthfully as one of the most interesting production sessions ever held by the Society. Over 200 were present and every man seemed to feel that he had profited greatly by his attendance. All of the talks were informal contributions to a scheduled round-table discussion of the question as to whether gears need to be ground to achieve reasonably quiet running. Representatives of the following companies spoke; Cadillac, Chandler, Lincoln, Packard, Reo and Studebaker. The more important points that were presented are recorded in the following report of the meeting. Because of their practical value, each of the informal discussions is to be printed in the form of a complete illustrated paper in a future issue of THE JOURNAL.

FUNDAMENTAL ANALYSIS OF GEAR NOISE

W. R. Griswold of the Packard engineering staff, opened the program with an interesting presentation of the elementary causes of gear noise. He called attention to the fact that two changed conditions are responsible for the present-day general complaints against gear noise; first, gear-ratios are much higher than in the past; second, a majority of the cars now being built are fitted with enclosed bodies.

If an alarm clock is allowed to ring inside a glass jar from which all air has been exhausted, its sound cannot be heard. Mr. Griswold cited this experiment to demonstrate that sound must pass through some medium to be heard. Vibration and wave motion are the source of all sound. Unfortunately, requirements of strength and durability force the use of the most resonant materials in transmission gears. Vibration is set up in these resonant metallic substances in three ways; first, by inaccuracies in the rolling surfaces of the teeth; second, by the elastic action of the gear teeth and the supporting shafts; and third, by the reversal in direction of the frictional forces as the gears rotate under load. Mr. Griswold called attention to the fact that the speed of sound is greatest through liquids and metallic solids, the two mediums of sound transmission present in all gear-boxes. He cited several interesting elementary physics experiments to illustrate the fundamental causes of noise.

METHODS OF ATTACKING THE NOISE PROBLEM

In conclusion, Mr. Griswold said that there were four ways of attacking the gear-noise problem

(1) Deliberate exhaustion of all experimental schemes, trying various modification of tooth form, pressure angle, pitch, material and bearings, until quiet is attained by a process of elimination

(2) Discovery of the causes by evolution or by accident, the least promising way, no doubt

(3) Determination of the causes and then controlling them at the source to prevent possibility of noise. This calls for extremely careful manufacturing and inspection

(4) Partially controlling the causes, and then applying corrective measures after the production of the parts, such as by grinding, burnishing, lapping or polishing

This presentation by Mr. Griswold of fundamentals served as an appropriate introduction to the talks that followed.

HOBBED AND OIL-TREATED GEARS MORE ACCURATE

Conclusions reached by the Studebaker manufacturing organization on the matter of attaining gear-accuracy were presented by O. H. Shaffer. Their studies of the gear problem have led them to favor cutting the gears more accurately by employing the hobbing process and then oil-treating them to avoid distortions in hardening. Curves were shown to illustrate the effect of carbonizing and hardening on an accurately cut tooth and to support the contention that hobbed teeth are more accurate than those which are milled or shaped. Both of the heat-treating operations tend to shorten the full depth of the green tooth, with a consequent deformation of its face due to the expansion of the thickness at the pitch circle. It is the opinion of the Studebaker men that gear grinding can be dispensed with if the teeth are cut with accurate hobs from a steel suitable for oil-treatment.

Cadillac Favorable to Gear-Grinding

L. A. Danse spoke for the manufacturing division of the Cadillac Motor Car Co. He said that their experience with the gear-grinding method had sold them completely on the advisability of grinding gear-teeth after hardening. He was most enthusiastic in his praise of the results achieved in the Cadillac plant saying that transmission tear-downs had been reduced from 30 per cent to less than 5 per cent of the daily production. Since these tear-downs cost in the neighborhood of $2.50 each, the saving is a material one and partly offsets the cost of the grinding operation. About 3 per cent of the old cut gears failed to pass inspection and had to be scrapped; grinding has reduced this loss to less than ⅛ of 1 per cent. Ground gears run so much more quietly than cut gears, that the Cadillac inspectors now complain about transmission bearing noises that were not noticeable before the introduction of the tooth-grinding process. Mr. Danse believes that the persistent campaign for quiet transmissions will lead to the development of transmission cases that will act as mufflers of the gear noises instead of tending to amplify them. He stated that Cadillac engineers are contemplating a change in the transmission to eliminate the so-called cluster gears on the countershaft, making them separate so that the teeth on all gears could be ground. This is indicative of their faith in the gear-grinding process as a noise deterrent.

Unquestionably, gear life is lengthened when the teeth are ground, Mr. Danse stated, but he was unable to quote any specific percentage, although this factor is under observation. He gave a very complete description of the gear-grinding machine used in the Cadillac works, but this will not be repeated here since it has been covered fully in THE JOURNAL[1].

Metallurgical Considerations

Gear-grinding was adopted in the Cadillac plant after a series of exhaustive experiments carried on over a period of years. Almost every conceivable kind of gear steel was tried in these experiments in an endeavor to overcome the warping of the teeth in the hardening process. Carbon-steels, nickel, chromium, vanadium and molybdenum alloy-steels were all tried in turn, but without appreciable success. These experiments led to the final adoption of S.A.E. Steel 3250, oil-treating stock, in all Cadillac transmission gears. Although many types of pots, compound and heating schemes had been tried, Mr. Danse said that he had been unable to carburize gears within 30 to 40 per cent of the accuracy obtainable with oil-treating methods. All manner of fixtures and clamps were used in trying to control distortion during the case-hardening process but without favorable result. All Cadillac transmission gears are now oil-treated; rear-axle gears have not been oil-treated as yet, but Mr. Danse believes that eventually this will be done with considerable success.

One of the most interesting contributions of the evening was Mr. Danse's comment on metal flow-lines in the forged gear-blank and their effect upon gear-tooth strength and gear distortion. At one time the Cadillac engineers conducted a series of impact tests on gear teeth to determine their ultimate strength. It was found that all teeth on the same gear did not have the same relative strength. Investigation showed that two of the teeth on a particular center-line had a maximum of strength and that those teeth on a center-line at right angles to this one of maximum strength showed a minimum of strength. After etching some gear blanks with acid to bring out any grain lines in the metal it was noticed that these lines passed through the blanks in the manner shown in the accompanying illustration. The teeth shown at *b*, having the flow lines passing through them longitudinally, proved to be the strongest teeth; the teeth shown at *a*, having the flow lines running across them, were the weakest teeth on the gear. Careful checking of results showed this condition to exist in all gears forged from the conventional steel billet.

[1] See JOURNAL, June, 1923, p. 545.

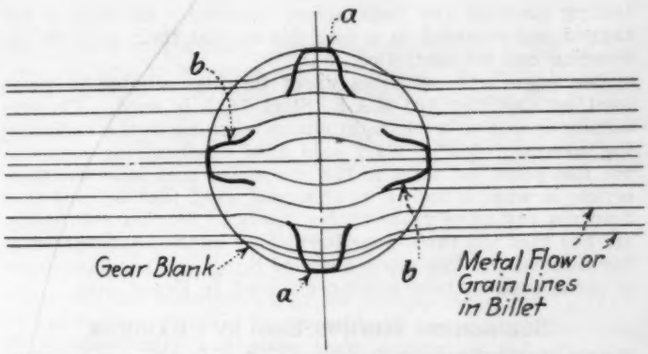


DIAGRAM SHOWING THE RELATION BETWEEN THE STRONG AND THE RELATIVELY WEAK GEAR TEETH AND THE GRAIN LINES IN THE BILLET

Upset Blanks Give Uniform Tooth-Strength

These tests demonstrated the desirability of using gear blanks in which the flow lines would radiate outward from the center of the blank. Experiments showed that blanks with this characteristic could be made by cutting circular discs from the end of round bar stock that had been subjected to an upsetting operation to produce the desired radial flow of the metal. Such upset blanks are now being used for Cadillac gear forgings.

Tests made on rear-axle bevel-gears showed that the weakest teeth on a gear cut from the forged blank withstood an impact of only 260 ft-lb; whereas, all teeth on a gear cut from one of the upset blanks withstood an impact of 1300 ft-lb. This is certainly an impressive increase in strength and can be attributed entirely to the fact that the metal flow-lines in the upset blank run radially through the teeth instead of running around the ring. This also has a marked effect upon the tendency to warp, the upset blank causing relatively little warping.

Lincoln Gears Burnished and Polished

R. E. Linn of the Lincoln production staff described methods of burnishing and polishing gear teeth that have proved effective in reducing gear noise. Burnishing is done by running the green gear in the middle of a group of three accurately cut and hardened gears whose centers are located on the vertices of a triangle. All three gears mesh with the gear being burnished. There should be a different number of teeth in the three hardened gears so that the effect of a hunting tooth is secured, thus preventing the meshing of the hardened teeth with the same spaces on the soft gear throughout the burnishing operations. This burnishing operation seems to roll or lay down the roughness of the tooth surface as left by the cutter and makes an appreciable improvement in the quietness of the gears. Each gear is burnished by rotating it for about 5 sec. in each direction.

Greater accuracy was attained in shaping Lincoln gear teeth by polishing the cutters used on the gear-shaping machines. A special polishing machine devised for this purpose is now used also for polishing the gears after the burnishing operation. This machine follows the generating principle of the gear-grinding machines now in general use but employs a rubber buffing wheel that is coated with tallow and emery-cake as an abrasive. About 3 or 4 min. is required to polish the average transmission gear on this machine. Ground gears can be polished by this method and the teeth given a mirror finish. Mr. Linn agreed that the grinding process was effective in correcting tooth-profile variations due to warpage in hardening.

Reo Has Rigid Cutter Inspection

Variations in gear teeth were traced by the Reo organization to inaccuracies in the cutters. W. G. Hildorf described a rigid system of cutter inspection used in the Reo works to assure new cutters being accurate and being kept so. All cutters are checked with a comparator and subjected to an additional test by inspecting two sample gears produced by each cutter, these gears being rolled together on a gear-

testing machine and their action observed. All cutters are tagged and recorded in a card file so that their periodic inspection can be controlled.

Reo gears are cut from upset forgings similar to those used by Cadillac, but S.A.E. Steel 1015 is used. The upsetting operation tends to minimize warping in the carburizing process. Mr. Hildorf said that observations made at the Reo plant led them to the conclusion that most warpage occurs in what is known as abnormal steel, that is, steel that does not carburize properly but tends to develop soft spots. He has used the three-gear burnishing method satisfactorily, but some of the Reo gears are now being ground, particularly those used in transmission-mounted in closed cars.

Burnishing Method Used by Chandler

A. H. Frauenthal, chief inspector of the Chandler Motor Car Co., wondered how far manufacturers could go in the way of expense to procure quiet gears and made the rather pertinent comment that each manufacturer is now scrambling to attain the same degree of gear-quietness as his competitor. The Chandler gears are made of chrome-carbon steel, oil-treated. He confirmed the Studebaker conclusion that oil-treating caused less tooth distortion than carburizing. Although all gears in the Chandler transmission are in constant mesh, a satisfactory degree of quiet is achieved by burnishing the teeth both before and after hardening. Gears are run for less than 5 sec. in the burnisher and only in one direction. Mr. Frauenthal said that gears could be spoiled easily by doing too much burnishing. He favored putting all back-lash in the larger gears since this affected the least alteration in the tooth contour.

December Meeting

The next production session of the Detroit Section will be held on the evening of Dec. 20 in the General Motors Building at 8 o'clock. Enameling of steel bodies with pyroxylin base materials will be the subject and will be treated from both the production and the engineering standpoints. The customary dinner at 6:30 p. m. will precede the meeting.

J. F. PALMER NOT WITH DUNLOP

Through a regrettable error in the story of the Buffalo Section's Oct. 29 meeting, on p. 429 of the November issue of The Journal, J. F. Palmer, who addressed the meeting, was reported as being connected with the Dunlop Tire & Rubber Co. Mr. Palmer is consulting engineer with the Hewitt Rubber Co. of Buffalo, and has no connection with Dunlop.

TO DISCUSS AUTOMOTIVE FUEL PROBLEM

American Petroleum Institute to Meet in St. Louis, Dec. 11 to 13

The American Petroleum Institute has issued the preliminary program for its fourth annual meeting to be held at the Hotel Statler, St. Louis, Dec. 11 to 13. Among the items of particular interest to the members of the Society are an all-day discussion of the automotive fuel problem on Dec. 12. At the morning session a paper on the Fuel Problem from the Standpoint of the Automotive Industry will be presented and Dr. G. K. Burgess, director of the Bureau of Standards, will outline the progress made in the cooperative fuel tests in a paper entitled, What is Good Gasoline? At the afternoon session W. S. James, of the Bureau of Standards, will present a paper on Service Tests of Lubricants in Automotive Engines, and Thomas Midgley, Jr., vice-president of the General Motors Chemical Co., will speak on the Progress of Anti-Knock Fuels. At the general session on the evening of Dec. 12 three papers will be presented, one of which, entitled What the Automotive and Oil Industries Can Do for Each Other, will be by H. L. Horning, general manager and secretary of the Waukesha Motor Co., representing the Society of Automotive Engineers.

The annual dinner will be held on the evening of Dec. 13 at 8 o'clock in the ballroom. An invitation has been extended by the American Petroleum Institute to any members of the Society who care to attend the dinner. Persons desiring tickets should make reservations promptly through the office of the American Petroleum Institute, 17 West 44th Street, New York City, and a check in the amount of $6 for each place desired should accompany all requests for reservations. If more than one ticket is requested the name or names of all persons should be sent to avoid duplicating reservations and to insure proper seating arrangements.

MAINTENANCE BIG TRANSPORT PROBLEM

Mid-West Hears Beecroft Analyze Truck and Bus Situation at November Meeting

David Beecroft

In the motor transport field there exists, between the producer on the one hand and the consumer on the other, a set of relationships that of necessity must be carefully considered if the greatest measure of success is to come to both parties for a given expenditure of effort and money. It was with this thought in mind that David Beecroft, general manager of *Motor Transport*, prepared the paper on The Relation of the Automotive Manufacturer to Motor Transport which he presented at the Nov. 9 meeting of the Mid-West Section.

The motor truck and the motorbus are 100-per cent machines of industry. They are just as completely dollar-earners for their owners as the printing press is for the publisher, as the steam-shovel is for the building contractor or as the locomotive is for the railroads.

Former Relation of Maker to User Discussed

Two major causes contributed to the lack of as close relationship between the builder and the consumer as would have been desirable during the past 3 years. First, according to Mr. Beecroft, came the influence of the system of passenger-car sales through the distributor and dealer plan of organization. This plan was too literally followed by not a few motor-truck merchandising policies and it kept the builder and the consumer apart, except as the former found it necessary to send his special sales representatives to assist the dealer in carrying out the sale. Where branch house organization was relied upon, a much closer contact between the two parties resulted.

Secondly, came the lack of a keen realization that motor trucks can only be well sold if sold by virtue of their dollar-earning capacity. To these two reasons for lack of close relationship between the factory and the consumer might be added a third contributing factor, namely the influence of the war with its unexpected demand for vehicles due to the stimulation of industry and also to the assistance the railroads required during those years. A clear vision of how the builder and the consumer should travel side by side and step by step in shaping the motor-transport industry during these, its formative days, has been lacking.

Engineer Must be Future Link

In considering the part the engineer should play in this work of closer relationships he should be looked upon as the representative of the producer, as he has been responsible for the design of the vehicle that has been sold into the dollar-earning zone of the user. Alongside of the engineer must be

considered the sales organization that has been the one connecting link between the factory and the user.

The consumer is purchasing transportation today, rather than buying chassis specifications. As Mr. Beecroft pointed out, the truck user or fleet owner has a transportation problem. He formerly used the horse as the power generator, his animal locomotive, if the term may be used. He built his entire system of transportation around this animal. The boundaries of his business zone were determined by the mileage capacity of the animal; the shipping room facilities were planned in accordance with horse pace and capacity. The horse was the key. Then came the motor truck which was injected into this horse zone, into this system of transportation that was framed around the animal. It was but natural to use the motor-truck first as a substitute; but there was no reason why the engineer and the builder should not have gone into the field and studied at first-hand the transport needs of the user and scientifically applied the vehicle to the work. Work of this character was started in 1911, but it was done largely by the sales end, the sales engineering end as it was frequently called. Unfortunately this work was not so general as it should have been. It was unfortunate, too, that the engineer was not more generally injected into this work.

Maintenance an Engineering Problem

Mr. Beecroft presented as a major consideration to which the attention of engineers should be directed the thought that the present design of vehicle must be greatly modified to meet the change in times. As engineers the work lies ahead. The engineer must get the owner's viewpoint and design what might be termed a maintenance engine, as well as a power engine or a factory production engine. All engines must be repaired, must be overhauled, must be rebuilt. When laying out the engine on the drafting board, the engineer should have three standards of measure before him. He must design

(1) A power generator on a par with or better than his competitor
(2) A powerplant that permits of economic production
(3) A powerplant that permits of economical maintenance in the hands of the user

Of these three, the last gives evidence of primary importance, but all three units of measurement should be before the engineer in all of his work.

Fleet Owners Study Transportation Costs

When one considers that these vehicles are dollar earners and that they can only earn dollars when they are in working condition, it will be seen why the owner is considering the maintenance aspect. Every day the vehicle is out of service for repairs means a loss of revenue. Earning capacity is generally proportionate to the number of days the vehicle is in service from the time of its purchase until it is discarded. Realizing this, fleet owners are consulting together not only on matters of performance and maintenance but also with regard to future purchases.

Here is an example of how a medium-sized fleet owner is studying his transportation costs with the object of obtaining greater efficiency. He has brought together the average yearly index price figures of all materials that enter into the operation and maintenance of his vehicles from 1917 to 1922, inclusive, in order that his accountants can analyze the costs more specifically and place their fingers on the offending items. Other owners of small fleets are installing perpetual inventories in order that the amount of money tied up in spare parts can be reduced to the minimum.

Fleet owners who have used motor vehicles for many years are, in not a few instances, creating transportation departments for the complete control of the vehicles. Department stores have been leaders in this activity, but it is now being taken up in several other lines of industry.

From 8000 replies of fleet owners in all parts of the Country the numbers operating their own service-stations are as follows, these replies being classified according to the number of vehicles operated:

Number of Vehicles	Per Cent
10 or more	88.9
5 to 9	79.9
3 and 4	60.4
1 and 2	46.0

This great percentage of private service-stations has only one message; their owners have set their teeth to the work of reducing the actual cost of repairing and overhauling and they have also set their faces toward the reduction of the time a vehicle is out of commission during such work.

Commenting further on the figures given above, Mr. Beecroft explained that the result in the case of the owners of three or four vehicles was due to the fact that they were in relatively small places and owned relatively high-priced trucks. In some cases, such a fleet would be made up of three different makes of the highest-priced trucks on the market. It does seem unfortunate that in a small town an operator should load himself up with three different makes of vehicle and carry the maintenance load that goes with it.

Some of the reasons given by the operators of three and four-truck fleets for maintaining their own service-stations are given below, taken direct from the replies referred to. This group was chosen to represent the general situation, as what applies to the small fleet owner applies in still greater proportion to the large operator.

Schedule of Sections Meetings

DECEMBER

3—Buffalo Section—Automotive Electrical Equipment—William Knopp
4—New England Section—Drop Forgings as Applied to the Automotive Industry—John H. Nelson
Inspection of Wyman-Gordon Co. plant, Worcester, Mass.
5—Proposed Milwaukee Section—Observations on My European Trip—H. L. Horning
Minneapolis Section—Air-Cushioning of Automobiles—V. V. Vannattan
6—Detroit Section—Shock-Absorbers—J. M. McElroy
Indiana Section—Four-Wheel Brakes—Round Table Discussion
7—Washington Section—Experimental Aeronautical Development—Major L. MacDill
13—Metropolitan Section—Vehicles for Package Delivery—Round Table Discussion
14—Mid-West Section—What I Know About Engineering—Edward S. Jordan
20—Detroit Section—Enamelling of Steel Bodies with Duco—Round Table Discussion

(1) It is of as much importance to have our own garage as to have our own shops
(2) We save 50 per cent by our own garage
(3) We can watch our trucks better
(4) We can keep our vehicles in good operating condition at less cost
(5) More satisfactory work is done by our own repair men
(6) The repair work is more accurate
(7) We get repairs made when we want them
(8) Cheapest in the long run and we have tried both plans
(9) Saves not only a great quantity of time but a vast amount of annoyance
(10) Our drivers take greater interest in our vehicles, knowing they are repaired by our own organization

What the future holds by way of possible equipment on motor trucks and buses can only be gaged by the dollar-earning value of these devices. There is only one reason that any equipment will live in the transport field and this is that it shows a profit when measured by the dollar-earning yardstick.

Mr. Beecroft cited the example of one builder of motor-buses who is meeting the new times that demand new measures and too often new men. This man had his engineer ride for weeks on certain bus lines to talk to the traveling public, without disclosing his identity, to get their point of view on the kind of buses they wanted. At the same time, a sales representative was taking the same course of training in another section of the Country, and in a third area, the bus driver was functioning similarly. The builder learned that the public wants to ride on rubber and to ride in comfort, and best of all, that it is willing to pay for such service. He learned that of two of his own buses operating on the same route, the greater earner was the vehicle that gave the comfort the public demanded and for which it was willing to pay the extra fare charged.

To sum up: Transportation is the business for which the vehicle was designed and the dollar-earning capacity of the vehicle, the yard-stick by which the user measures its success.

In the discussion which followed, W. Z. Pride of the Autocar Co., described in detail the development of cost accounting among fleet owners to lower maintenance costs.

H. L. Horning of the Waukesha Motor Co., pointed out that no great designer ever attains anything in design unless he translates his knowledge of design into things that will fit human nature. Any designer who thinks that his idea of a design on paper or in steel is more important than the idea of the man who is using it, is making a purposeless design. Following this train of thought, Mr. Horning suggested possible improvements that might be made in the design of motor-truck electrical equipment, spark-plugs, push rods and carbureters. He also laid special stress on the need for improvement in the design of valves to facilitate quick removal and in the design of drivers' seats for greater comfort and a consequent increase in efficiency. Temperature and the composition of the lubricating oil as maintenance factors were also brought forward by Mr. Horning.

At the next meeting of the Mid-West Section, Edward S. Jordan, president of the Jordan Motor Car Co., will speak on What I Know About Engineering. The meeting will be held on Dec. 14 in the rooms of the Western Society of Engineers, 330 South Dearborn Street, Chicago. It will be preceded by an informal dinner at 6:30 p. m. in the Chicago Engineers Club, 314 Federal Street.

NEW ENGLAND WILL MEET IN WORCESTER

Another combination of technical meeting and plant inspection has been planned for the meeting of the New England Section that is to be held on Dec. 4. Drop Forgings as Applied to the Automotive Industry will be the topic of the paper presented at the technical meeting at 8 o'clock in the Bancroft Hotel, Worcester, Mass. John H. Nelson, head of the experimental department of the Wyman-Gordon Co. of Worcester, will be the speaker. In the afternoon, members of the New England Section and their guests will be conducted through the Wyman-Gordon plant.

AUTOMOTIVE ELECTRICAL EQUIPMENT

For its meeting on Dec. 3, the Buffalo Section has scheduled a paper on Automotive Electrical Equipment by William Knopp, sales engineer of the Dayton Electrical Laboratories Co. The meeting will be held at the Statler Hotel, Buffalo, beginning promptly at 8 o'clock. There will be no dinner before the meeting this month.

REPAINTING AND REFINISHING

Processes for Bodies, Hoods, Fenders and Wheels Described by C. O. Thomae

Hoods, fenders and wheels must stand more wear and tear than automobile bodies, but less care is, as a rule, paid to the repainting and the refinishing of these parts. For this reason C. O. Thomae, technical representative of Valentine & Co., paid particular attention to their treatment, in his talk on Repainting and Refinishing of Automobile Bodies at the Nov. 2 meeting of the Washington Section.

To make the study of materials and methods more vivid to his hearers, Mr. Thomae suggested that they imagine themselves opening a paint shop to which cars are brought for refinishing. Five basic types of materials are required for a complete automobile painting system: Priming, surfacing, coloring, rubbing and finishing. Before any work is begun, the proper color must be selected. The owner should be consulted to make sure whether he wishes the car restored to its original color or to the darker tone it has reached in use. Such a consultation will save trouble later, and a complete record of the condition of the car when received in the shop as to dents, plating, interior upholstery, make of tires and similar information will also save complaints.

Preparing for the Color Coats

For removing the old paint, any of the paint and varnish removers on the market will do. It should be put on with an old brush, one coat after another, until it shrivels the paint, which can then be removed with a broad-bladed putty knife. The surface should be sandpapered smooth and great care should be taken to remove completely any rust spots, for rust will eat through any number of coats of paint. Mr. Thomae recommends deoxidine as a rust remover to be followed by careful washing with clear warm water.

Before applying the priming coat, the entire surface must be wiped off with a mixture of denatured alcohol and water to remove all grease and dirt. The priming coat, the foundation or anchor for the succeeding coats, should be spread on thin and brushed out evenly, as it will not stick if too heavy a coat is put on. It is important to adapt the primer to the surface treated. Lead colors can be used on wood, but they will corrode aluminum.

After the priming coat has had the proper time for drying, it is followed by what is called half-and-half, a mixture of equal parts of keg lead and roughstuff. Some painters sandpaper the priming coat, but Mr. Thomae objects to this practice because the sandpapered priming coat is easily cut through, especially at the edges. Sandpapering also removes the moisture-proof film. Another bad practice is glazing bodies with hard putty over the entire surface. This could be avoided by sending the body to the paint shop with fewer file marks and imperfections and a better paint job could be turned out.

Surfacing comes next. On high grade work, roughstuff is used and from three to five coats are applied according to the condition of the metal. Roughstuff is brought down to a smooth surface by using water and sandstone, followed by lump pumice to give it smoothness. The surfacer used on

rush work or work of cheaper grade is called sanding surfacer. As it is a shorter material, sandpaper can be used to give it a smooth surface; but if dry sandpaper were used on regular roughstuff, it would gum up on the paper. Great care must be taken to dry out all moisture after the roughstuff has been rubbed with sandstone and water. It should stand at least over night. The following day, No. 00 sandpaper should be used to clean out the corners and take off the sharp edges. The body is then ready for the ground color.

From Ground Color to Finish

The ground color should stand about 4 hr. before receiving what is called second coat color, which should also stand about 4 hr. The proper way to mix Japan color is to beat it up thoroughly with a wooden paddle and then add the turpentine gradually, stirring as the turpentine is added. This will produce a smooth color to work, but if the turpentine is poured in all at once, the color will have a sandy, gritty appearance.

The first coat of color and varnish should be applied in a room where the temperature is not below 70 deg. to give it freer working. The proportion of color to varnish should be about 2 to 4 lb. of paste color to 1 gal. of varnish, depending on the color used. In mixing color and varnish, apply the rule used for mixing the color. Beat up the Japan color with a paddle and add the varnish to it gradually. Care should be taken to have this first coat of color and varnish absolutely solid covering. The time allowed for drying will vary with the materials used.

Before the second coat is applied, it is usual to moss off the gloss and nibs or to remove them with wet sandpaper. Edges that have been cut or stripped should be carefully touched up. After an examination to make sure that the color is solid, any particles of grit that remain on the surface should be picked up with a tack rag, made as follows: Dip into rubbing varnish a piece of cheesecloth about the size of a large handkerchief, squeeze and spread out to dry until it becomes tacky.

In applying the second coat of color and varnish, use the proportions of the first coat of color and varnish and add to it about 50 per cent of rubbing varnish. In building up, the pigment should gradually be cut down. After the second coat has thoroughly dried, it should be rubbed with powdered pumice stone and water or with wet-or-dry sandpaper. Clean up with the tack rag before applying the third or tint coat. When this third coat has stood the required length of time, it should be rubbed with pumice stone and water and the necessary striping done. The next day the finishing coat can be applied.

There are two methods of preparing the body for the finishing coat. One is to rub slightly with rotten stone and water, wash clean, tack-rag and finish. The other is to use a mixture of a cup of gasoline in a pail of water and one or two spoonfuls of olive oil. With this mixture a piece of silk is used, squeezed out almost dry.

Before taking up the special problems of painting the hood, the fenders and the wheels, Mr. Thomae gave his audience some pointers on the color operation and sanding surfacer. Blue needs special treatment. If it is a medium or dark blue, a little varnish or linseed oil should be added to the color, and after standing about 4 hr. the blue color and varnish should be applied. If blue is allowed to stand too long, it gets so hard that when the color and varnish is applied it does not get a chance to feed on the hardened color and will not give a solid covering. After the third coat of color and varnish, the blue should be protected with a clear coat of rubbing varnish to help keep out the moisture.

The sanding surfacer should have what is called a sealer coat before the regular Japan color is applied, to add elasticity. Some painters make the mistake of trying to crowd the two operations into one by mixing a sealer with the color. The sealer is meant to go into the pores and penetrate the short material, but when the sealer is mixed with the color, it does not get a chance to do the work for which it is meant.

Painting the Hood, Fender and Wheels

The first step in painting the hood is to clean it thoroughly from all paint, grease and dirt before applying a coat of primer. If the metal is not smooth, apply one or two coats of sanding surfacer. When dry, sandpaper right down to the metal, leaving only the imperfections in the metal filled. After another coat of primer is brushed on thin, the operations outlined for painting the body can be followed with the exception of the finishing coat. This should be tougher varnish than the regular finishing varnishes used for the body, as the contraction and expansion are much greater on the hood.

The repainting of the fenders should be done in the same way, except that if the fender is to be black, a black primer should be used, followed by two coats of black color and varnish and finished with the tougher varnish used for the hood.

Disc wheels can be repainted by the method used for the hood, but fewer coats will be needed. On wooden wheels, after the paint has been removed and the surface thoroughly cleaned, a coat of primer should be applied, followed by putty glaze, if necessary. This should be sandpapered down absolutely smooth, before a second coat of primer is put on. The usual method of color, color and varnish, stripe and finish completes the job.

If a car is to be recolored, it should first be looked over very carefully for bruised spots. These should be patched with primer and filled up with glazing surfacer or roughstuff. When all grease has been removed with gasoline, the surface should be rubbed with pumice stone and water or wet-or-dry sandpaper. When the bare places or patched spots have been touched up, the regular routine of color and varnish and so on, as outlined for repainting the body, should be followed. If the color is to be changed, it will be necessary to apply a coat of flat color before the color and varnish is put on.

Asked about the refinishing of a car with a baked enamel surface, Mr. Thomae said that it is possible to refinish such a car without removing the enamel, but that because of the greasy or oily nature of the finish particular attention should be paid to the surfacing. Washing with benzol or alcohol should precede the priming coat.

One frequent cause of white spots on the cowl and the hood, according to Mr. Thomae, is the use of a strong blue or strong gray color varnish immediately under the finishing coat. Another is the use of too "short" or inelastic a finishing varnish, with a consequent spotting on the hood and the cowl which, because of their nearly flat position, are most directly attacked by the actinic rays in the sunlight.

An inelastic coat put on top of an elastic coat is responsible for the appearance of large cracks that show up beneath the surface like aligator skin, as a sample panel shown by Mr. Thomae demonstrated.

Major Leslie MacDill, of McCook Field, Dayton, Ohio, will give an illustrated talk on Experimental Aeronautical Development at the next meeting of the Washington Section, to be held in the lecture hall of the Cosmos Club on Dec. 7, at 8 o'clock.

MILWAUKEE TO HEAR H. L. HORNING

The Milwaukee group will vary its program of meetings on transportation problems at the December gathering when H. L. Horning, of the Waukesha Motor Co., will have for his topic Some Observations on My European Trip. The meeting will be held in Library Hall of the Milwaukee Public Library, Grand Avenue between Eighth and Ninth Streets, at 8 o'clock on Dec. 5.

AIR-CUSHIONING TOPIC AT MINNEAPOLIS

V. V. Vannattan is slated to present the much-discussed topic, Air-cushioning of Automobiles, at the Dec. 5 meeting of the Minneapolis Section. The meeting will be held, as usual, at 8 o'clock in the Manufacturers Club, Builders Exchange, Second Avenue, South, between Sixth and Seventh Streets.

FALGE SPREADS HEAD-LAMP INFORMATION

The Dayton Section of the Society shared its Nov. 6 meeting with the Dayton Engineers Club. R. N. Falge, of the National Lamp Works of the General Electric Co., spoke on the Importance of Better Automobile Head-Lamps and Proper Adjustment. This was substantially the same successful paper that Mr. Falge presented at the Summer Meeting and in a revised form at the Metropolitan Section's September meeting. The full text of the Summer Meeting paper was printed on pp. 25 to 29 of the July issue of THE JOURNAL. A summary of the points brought out in the discussion at the Metropolitan Section meeting and substantially all of the additional material that Mr. Falge presented at that time will be found on pp. 350 to 352 of the October issue of THE JOURNAL.

No meeting of the Dayton Section will be held in December.

SAN FRANCISCO MEMBERS MEET

Members of the Society living in San Francisco and its environs held a successful and well attended meeting on Nov. 22 at the Hotel Whitcomb in that city. W. S. Crowell gave an interesting talk on brakes and George G. Crackel of the Firestone Tire & Rubber Co. presented some of the advantages of low-pressure tires. These Pacific coast meetings are being arranged by A. A. MacCallum, who may be addressed at 115 New Montgomery Street, San Francisco, by any of our members who are interested.

PYROXYLIN-BASE PAINT MATERIALS

Dupont Engineer to Describe New Chemical and Methods of Using It

Duco, the new Dupont pyroxylin-base finish, will be thoroughly discussed, especially in relation to the enameling of steel bodies, at the monthly production meeting of the Detroit Section on Dec. 20. A Dupont engineer is expected to discuss the new finish from the technical and engineering standpoint, including a survey of the research and development work on it. Russel Rogers, of the Oakland Motor Car Co., will speak on Duco from the production standpoint.

The meeting will be held in the General Motors Building, Detroit. It will begin promptly at 8 o'clock on Dec. 20, after the customary dinner at 6:30 p. m.

THE ENGINEER AND THE USED CAR

Most Important of Dealers' Problems Discussed at Cleveland Section Meeting

In opening his talk on The Relation of the Engineer to the Used-Car Problem, at the Nov. 19 meeting of the Cleveland Section, David Beecroft, general manager of *Motor Transport*, laid stress on the fact that he was not offering any cure-all for the used-car situation, the greatest problem with which the industry is faced today.

It is almost an eternal question as to whom this problem really belongs. Mr. Beecroft quoted Edward S. Jordan, president of the Jordan Motor Car Co., to the effect that the greatest problem facing the automobile builder today is to find some way of protecting the public against the automobile dealer who sells that builder's product second hand without any definite policy on rebuilding, pricing, advertising and servicing.

BANKS FEEL SERIOUSNESS OF SITUATION

So important has this used-car problem become that a few months ago the Federal Reserve Bank of Chicago began taking note of it, and no small concern is felt among Chicago dealers because of this latest factor injected into the problem. Each month the Federal Reserve Bank sends blanks to all Chicago dealers asking them these specific questions on their used-car business:

(1) How many used cars did you sell in October?
(2) How many used cars did you buy in October?
(3) How many used cars had you on hand Oct. 31?
(4) How many used cars did you buy in October, 1922?
(5) How many used cars did you sell in October, 1922?
(6) How many used cars had you on hand Oct. 31, 1922?

The reason for this latest attention of the Federal Reserve Bank is not difficult to find. The bank is looking for the protection of its member banks who are financing dealers, and the bank has become conscious of the fact that the ability of the dealer to sell new cars depends on his ability to dispose of the used cars he has on hand profitably, and also on the profits or losses he sustains on them.

NO PROFIT IN USED CAR FOR DEALER

The very great increase in the sale of new cars during 1923, when estimates placed the number of new sales at approximately 3,800,000 vehicles, has resulted in more used cars being in the hands of dealers today than in any previous year at this season. It has been the pressure of the factories on the dealers to dispose of the greatly increased volume of new cars that has resulted in the loading up of the dealers with used cars. The trade-in percentage in new-car sales has increased this year, as compared with former years, and the dealer is confronted with a more serious used-car situation than ever before.

If the dealer could sell used cars so as to make money on them, there would be good business in selling used cars, but today the dealers lose money on the used cars, their profits are consumed and 30 per cent of them are forced out of business. The October bulletin of the National Automobile Dealers Association reported used-car losses at $5,654,000 lost by dealers for the 3 months ended Oct. 1. These dealers had 399,600 used cars on hand on Oct. 1, as compared with 430,000 on April 1. For the first 3 months of 1923, these dealers had on hand stocks of used cars that had cost them $152,000,000. They admitted that this figure was $23,000,000 above the market price of the cars, and later reports proven this estimate to be true. It is plain that these dealers pay too much for the used car and so cannot sell it at a high enough figure to make a profit.

The dealers are faced with the interesting fact that they are about the only merchants in the community whose merchandise returns to them after it has been sold, and they find that their major problem in business is not selling new automobiles, but in buying used vehicles once, twice and in some cases three times. This purchasing problem is the real crux of the used-car business. This is where the money is lost.

Why cannot the dealers sell the used cars at a profit? The first and a very important reason is that very often the dealer discovers that he cannot rebuild used cars as they should be rebuilt and then sell them for what they are really worth. The public lacks confidence in used cars that are not rebuilt, but sold on what is known as the "as is" basis, that is, sold just as purchased second hand from the consumer.

Why have so many dealers sold used cars on this unsatisfactory "as is" basis? Letters from representative dealers in all parts of the Country show that dealers doing business in districts where conditions differ and selling new cars that go into distinctly different fields, give very similar reasons for the present trouble. A summary of these letters makes it plain that the dealers feel that if the cars are originally built properly by the engineers, or by reason of their design, there is longer life in the cars, it costs less to overhaul them and the used cars will bring higher prices. There is evidently a very definite feeling that it lies within the province of the engineer to contribute materially to the solution of the used-car problem. It should further be kept in mind that the public feels there is a much closer relationship between the engineer and the used car problem than many engineers are conscious of.

ENGINEER VITALLY CONCERNED IN USED CAR PROBLEM

The engineer must stop designing cars for himself or as he is told to design them by the sales department. After all, it is the owner who sets the price on a used automobile.

For example, the excessive amount of time required to handle the electrical unit has become very generally known among owners and undoubtedly has resulted in a reduction in the sale of the new car of that make, as well as in the market value of the car as a second-hand product, according to a member of the Society in charge of one of the largest electric service organizations in the Country.

On this point, Mr. Beecroft quoted a large dealer who has been selling a high-priced automobile for the past 20 years. This dealer maintains that there is no question but that the lack of accessibility has been a serious handicap in the sale of used cars. He has found it very difficult to sell a thoroughly rebuilt car and make money on the resale, because the cost of rebuilding is so high, because of the design or lack of design and also because of the cost of spares. It is not good business to sell second-hand cars in "as is" condition, but it is too often necessary to do so.

As to the desirability of rebuilding the second-hand car before selling it, rather than disposing of it in the "as is" condition, Mr. Beecroft believes there is little ground for dispute, even when the low-priced cars are considered. One dealer reports that the used car, when reconditioned and repainted, even in the under $1,000 field, finds a ready sale at a more substantial price, which thus helps to standardize car values. The engineer's relation to the used-car problem plays a very strong part, as beyond a question, a used car has considerably more value when its mechanical condition is good. Another point where the engineer plays a part is in the supplying of mechanical units so that their replacement will be comparatively easy when a car is being reconditioned for resale.

Nevertheless, according to one dealer handling a car listed at under $1,000, it is not expected that the improved designing or engineering of a motor car will entirely eliminate the used-car burden from the trade, because many people like to change cars every year or so, even though the present car is running well, just to secure the most recent change in lines or finish.

Still another dealer quoted by Mr. Beecroft believes that the mechanical or engineering department of an automobile dealer must decide how much should be spent upon used cars before they are offered for resale. That is where the engineer comes in, and it would tie the factory up much closer to the owner if it were incumbent upon the engineering department of the factory to give advice and pass on the rebuilding work.

Mr. Beecroft put the question up to the engineer by asking whether automotive engineers have not given more thought to obtaining a certain result in the way of performance than they have to the ultimate cost of operation. The owner gets his first impression of the engineering that has gone into his car from the amount of the repair bills. The work of the engineer is measured by the years of service in the vehicle, and the older the car becomes, the more apparent and conspicuous becomes the work of the engineer. If the work of the engineer is poor, production, merchandising and servicing, all dependent on design, come tumbling down like a house of cards.

In the discussion that followed Mr. Beecroft's paper, John Younger, chairman of the Cleveland Section, commented on the tremendous waste involved in scrapping worn-out automobiles. One and a half million cars will be sent to the scrap heap this year, and averaging 2000 lb. for each car, at about $0.35 per lb., the sum involved is large enough to be considered seriously. Between 25 and 50 little parts wear and cause a used car to be scrapped. If the engineer made those parts slightly bigger or heavier or put better metal into them, they would not give trouble.

If a car has been used for some time, only one thing can be done; have it overhauled completely. Whether the car is accessible or inaccessible does not make much difference, it should be torn down, every piece scrutinized and inspected and then rebuilt. It is surprising how much stuff can be used, avoiding waste and reclaiming some of the huge quantity of material now thrown away.

It is the opinion of Mr. Buckman, manager of the Cleveland Automobile Dealers & Manufacturers Association that the used car can be, and should be, made an asset in the dealer's business. The greatest asset that the automobile industry has in the moving of new cars is the used cars now in the hands of the American public. In other words, when a man has a used car, he has the first payment on a new one. He has not only the desire to own another car, but he has a big step in the payment for that car. It remains a question, therefore, whether the used car should be traded on that basis or whether it will be made a bunch of junk. An automobile is transportation; it is so much mileage. Even if the car is traded in, there is still mileage left in it. The next thing to do is to convince the public of this. No one dealer or builder can do that alone. The dealers must get together to bring the used car up to a definite standard and then impress that standard on the public with the assurance that it is being lived up to. Mr. Buckman explained that it is just that which the Automobile Dealers & Manufacturers Association is trying to do in Cleveland. The used-car bureau of the Association inspects the cars and places the seal of the Association on them to testify that they are worth the money asked. This is a constructive effort to make the used car an asset, instead of a liability, as it now is. Advertising seems to be the way to establish the true worth of the used car in the minds of the public.

MEASURING RIDING QUALITY

Indiana Section Hears T. J. Litle, Jr., Describe Ingenious Testing Methods

T. J. Litle, Jr.

Unique methods of studying engine and chassis vibration and riding quality were revealed to the members of the Indiana Section at their November meeting, which was attended by more than 150 men. T. J. Litle, Jr., chief engineer of the Lincoln Division of the Ford Motor Co., read a most interesting paper setting forth some novel experiments he has made in an effort to locate and eliminate disagreeable vibrations. He also described a mechanism for recording relative body and axle movement of a car when in operation. Mr. Litle's complete illustrated paper will be found in this issue of THE JOURNAL, starting on page 445. Some of the points raised in the discussion of the paper are reported in the following paragraphs. Asked whether he thought balloon tires would ever be developed to a point where they might replace chassis springs entirely, Mr. Litle replied that he did not. They improve the riding quality of a car without any question, but it is best to secure the full value of the combination of low-pressure tires and springs, neither being wholly adequate alone. It has been his experience that some type of shock-absorber is necessary with low-pressure tire equipment. This is particularly true of the front of the car. This experience of Mr. Litle checks with that of other engineers who have experimented with low-pressure tires.

Shock-Absorbers Should Have Neutral Zone

From rather comprehensive tests, Mr. Litle has concluded that hydraulic shock-absorbers are very effective in improving riding qualities. He spoke particularly of a type developed at the suggestion of his company which is arranged with a neutral zone for slight movements of the spring so that the shock-absorber is actually inoperative on rela-

tively smooth roads. Without this neutral arrangement, the hydraulic shock-absorber restrained the spring action so that the effect of using a stiffer chassis spring was apparent. Shock-absorbers should be inoperative on smooth roads. Lubrication between the spring leaves is favored by Mr. Litle. He is also partial to the use of spring-covers as a means of keeping out dirt and water from between the leaves.

J. H. Hunt, of the General Motors Research Corporation, wondered whether the comfort of the car-rider was not more correctly measured or represented by records of acceleration and deceleration of the car seat. Mr. Litle agreed that it was, but said the device described in his paper had enabled him to make a productive study of different combinations of spring leaves of varying length and thickness. He recalled a method described some years ago before a meeting of the Society where a photographic record was made of the movements of lights attached to the passengers, chassis and body, as the car was driven over an obstruction.[1]

W. G. Wall suggested that perfectly definite measurements of axle and body movements could be taken if it were possible to mount the instrument on a horizontal reference line in the air. This suggested the possibility of mounting a seismograph on a trolley wire above the road. He also spoke briefly on the problem of synchronizing or harmonizing the front and rear springs and agreed with Mr. Litle that a neutral zone is desirable in shock-absorber action.

Balloon Tires Interfere With Wheel-Housings

One difficulty met with balloon tires by Mr. Litle was their interference with body wheel-housings when standard wheel-tread and rear-seat widths are used. Edward Schipper said that some cars were using a 60-in. tread when low-pressure tires were fitted to avoid this interference.

Asked whether he had tested cars with the front-axle location in varying fore-and-aft positions on the spring, Mr. Litle replied that he had, and that his tests substantiated the general practice of having the axle located well forward of the spring center. One objection that he has found with low-pressure tires is their tendency to set-up violent front-wheel shimmy, particularly at high speeds.

Four-Wheel Brakes to Be December Topic

The Indiana Section's next meeting will be held on the evening of Dec. 6 in the Hotel Severin, Indianapolis. The topic will be Four-Wheel Brakes.

ACCURATE BRAKE PERFORMANCE TESTS

W. S. James Describes Bureau of Standards Recording Decelerometer and Results

W. S. James

An extremely interesting analysis of motor-car brake fundamentals was presented at the November meeting of the New England Section by W. S. James of the Bureau of Standards staff. It was evident to all present that the Bureau is starting its study of braking from rock-bottom and that this method of attack is uncovering the basic principles of decelerating motor cars. Mr. James gave some very convincing demonstrations of brake action with a miniature automobile fitted with electrically-controlled brakes on all four wheels. He also exhibited and explained the operation of the Bureau of Standards recording decelerometer that has made it possible for the Bureau engineers to analyze brake performance more accurately than has been possible with the measured stop-tests universally used in the past by other experimenters. This very valuable device is described fully on p. 499 of this issue of The Journal.

No attempt will be made in this brief report to present an abstract of Mr. James remarks since they are to be the basis of a very comprehensive paper that he will present at the Annual Meeting in Detroit next month. However, it will be of interest to record a few of the conclusions drawn from the tests and observations that have been made with the Bureau of Standards decelerometer and the other brake studies made by the Bureau engineers.

After spending some little time on elementary mathematical analyses of the forces acting on a car during deceleration, Mr. James emphasized the following fundamental facts:

(1) The retarding force acting on the car is proportional to the change in speed per unit of time, regardless of what units of speed and time are used

(2) The distance within which the car is brought to rest is directly proportional to the square of the velocity from which it is stopped, and inversely proportional to the deceleration in feet per second per second

Although the stopping distance varies largely with a change in the speed of the car, the deceleration in feet per second per second or the resisting force per pound of car weight is practically independent of the car speed. This latter fact has made the study of brake performance relatively simple.

Lacking reliable data on the coefficients of friction between the tire and the road, the Bureau of Standards made some rather crude but enlightening tests by towing a section of an automobile tire, weighted with a uniform load of 50 lb., over various types of surface and measuring its resistance to motion with a spring balance. The highest coefficient of friction observed in these tests was between dry glass and a tire tread of a rather poor grade of rubber. The samples were pulled with the tread both parallel with and crossways to the direction of pull so that coefficients were observed for a straight-ahead slip and for a slip sideways. Note was made of the pull at which sliding started and that necessary to maintain sliding at a relatively slow speed. Mr. James emphasized that the numerical data obtained were not to be taken as applicable directly to cars on the road but rather as indicative of some of the relations that may hold in ordinary braking service. It was observed that more pull was required to maintain sliding of the tire than that required to start it. If this result is substantiated by later experiments, it may disprove the present general conception that the coefficient of friction drops when the tire starts to skid on the road. Another interesting observation was that the resistance to sliding in a sideways direction was almost the same as that in a fore-and-aft direction.

Coefficient of Wet Concrete Higher Than Dry

One surprising result of these tests was the difference in the coefficient of friction between hard-surfaced pavement when wet and when dry. Tests made in water puddles on a concrete road indicated that the coefficient of friction was higher in the puddle than on the dry road. Mr. James attributed this to the presence of dust and dirt on the dry pavement which acted as a sort of ball-bearing support to let the tire slide easily. This was not present in the case of the wet concrete and the coefficient increased as a result. With the maximum coefficient of friction found between tires and roads of different types, the maximum deceleration attainable lies in the neighborhood of 23 ft. per sec. per sec. All of the tests on hard surfaces showed that the pull on the tire was practically independent of the tire-tread configuration, but was influenced by the character of the tread rubber. Soft rubber had a higher coefficient of friction, hard rubber a lower one.

Mr. James gave a brief mathematical analysis of the

[1] See The Transactions, vol. 12, part 2, p. 462.

forces and reactions that act on a car to produce skidding. This led him to mention the importance of the relation between side resistance and straight-ahead resistance in tires now that higher deceleration is possible with four-wheel brakes. If a car should be turning on a 30-ft. radius at 20 m.p.h. it will have a force acting to slide it sideways equivalent to 1 lb. per lb. of car weight and it will become very difficult to overcome that force with the side resistance of the ordinary tire. This emphasizes the importance of banking curves on new highways with the advent of higher decelerations. Mr. James remarked that if we are to use brakes that stop a car quickly, we must also stop the car safely, and that calls for some discretion on the part of the driver. We must become educated to use decelerating forces that are capable of imposing a 2000-lb. load on a 3000-lb. car when it is being decelerated at 20 ft. per sec. per sec.

A large number of representative records taken with the Bureau of Standards decelerometer were shown to the audience in slide form. From these Mr. James indicated several interesting points. He showed that the name "emergency-brake" is certainly a misnomer for the average hand-brake, since it seldom exceeds a deceleration of 8 ft. per sec. per sec., whereas the foot-brake comes nearer 13 ft. per sec. per sec.

Why Balloon Tires Improve Braking

What may prove to be the explanation of the improved braking performance of cars fitted with low-pressure tires was found in studying the decelerometer records from one series of tests made by Mr. James. Four records were taken on the same car, the tire inflation-pressures being different in each case, varying from 70 to 25 lb. per sq. in. The car was driven over smooth asphalt pavement and stopped from a speed of 35 m.p.h. In the case of the tire inflated at low pressure, the decelerometer record is a fairly straight line, showing that the rear wheels held the ground and the decelerating force was acting all of the time. In the case of the higher pressures, the line on the record was decidedly irregular, showing that the rear axle was bouncing or vibrating on the road, the brakes not being wholly effective until the car speed had been materially reduced.

Another interesting point shown by the performance tests was the drop in braking efficiency when the brake-drums and linings become hot. In one case this change in conditions caused a drop in deceleration from 11.5 to 9 ft. per sec. per sec., the latter figure being for the hot brakes.

Rather active discussion was held after Mr. James concluded his remarks and the meeting did not adjourn until a late hour. The attendance reached nearly 100 persons and all joined in voting the meeting one of the most interesting ever held by the New England Section.

DAYTON SERVICE MEETING

Important Discussion Favorably Received by Service Men and Engineers

The most constructive national meeting ever held for the purpose of promoting more adequate and satisfactory automotive service was that conducted in Dayton, Nov. 20 and 21, under the joint auspices of the National Automobile Chamber of Commerce and the Society. About 200 men interested in service and engineering were present. They came from all sections of the Country; nearly every motor-car builder was represented. The sessions were well attended and the numerous talks enthusiastically received. Quoting one prominent service manager, "the Dayton meeting was a humdinger."

This was the first joint gathering of the N. A. C. C. and the S. A. E. on service matters. Without any question, the plan of combining forces increased the attendance, the interest and the effectiveness of the meeting; there is little doubt that the Society is favorable to the holding of such joint meetings annually.

A complete illustrated report of what transpired at the Dayton meeting is set forth in the following columns. C. F. Kettering's introductory talk was a distinct hit. The papers on head-lamp adjustment, lessons from the flat-rate, dilution, electrical repairs and simplicity of repair tools contained many valuable suggestions. W. T. Kreusser's analysis of service repairs for the use of car designers gave every man present plenty to think about.

Excursions were made to McCook Field, the Delco and the National Cash Register Co. plants, and to the laboratories of the General Motors Research Corporation. A large number of those in attendance made these visits. Congratulations are extended to the Service Committee of the National Automobile Chamber of Commerce, the local committees in Dayton and the several speakers, on the unqualified success of this important gathering for the promotion of better automotive service.

KETTERING ANALYZES SERVICE EVILS

Trained Rural Mechanics, Lower Repair-Part Costs and Correlated Effort Needed

C. F. Kettering

C. F. Kettering made some frank but decidedly constructive comments on automobile service in the opening address of the meeting. One thing is certain; he dispelled any optimistic feeling that service as rendered today represents the public's conception of what real service should be. The talk was given in Mr. Kettering's characteristic vein of humor, each point being illustrated by examples of his and other motorists' experiences. He emphasized three major points as important in the campaign for better service: first, a closer correlation of the engineering, sales and service departments; second, reduction of repair-parts costs; third, educational work directed at the small-town garageman.

It is extremely important that the automobile engineer's office be located adjacent to those of the service manager and the cost accountant, in Mr. Kettering's opinion. In a great many cases, cars have been designed with production and sales costs solely in mind; service requirements have been slighted in the struggle for lowered production costs. In the future, this attitude can not be tolerated. Mr. Kettering urged those present to return to their factories with a determination to convince their superiors that a closer correlation must be effected between the sales, engineering and service activities of their companies. Recognition must be taken of the fact that the primary function of service is to contribute something toward more satisfactory operation of the car in the owner's hands and the provision of transportation at a minimum of cost to him.

Designers Must Recognize Service Requirements

Many of Mr. Kettering's remarks were directed at the car designer. He said that designs which made it necessary to lift the body to remove the generator, or necessitated removal of the radiator to fit a new fan-belt, were inexcusable and would not be accepted by the public in the future. Analyzing the cost of operating a passenger car, he emphasized the relative importance of depreciation and maintenance expense as opposed to fuel cost. Engineers might better concentrate on lowering the first-mentioned items than devote too much thought to fine carbureter adjustments to effect an increase in the fuel economy of 10 per cent. Suggestions received from dealers and repairmen should not be ridiculed by the engineer. Although such reports are at great variance in most instances, it must be remembered that engineers find it difficult to agree on a solution of some problems. Tests made by garage-men are usually

superficial and the results misleading, but this does not excuse the engineer from listening to them with some appreciation of the repairman's interest in improving the design.

If the automobile business is to succeed in the future as it has in the past, the men at the factories must travel the highways and the byways where they can appreciate better the brand of service encountered by a large majority of the motoring public. Mr. Kettering emphasized this fact by stating that 65 per cent of the motor cars in this Country are owned and operated in territory that is remote from the large cities and their efficient service-stations. About 65 per cent of the cars are repaired in what he characterized as hick-town garages. Engineers must recognize this condition and design mechanisms that fit the capabilities of the average repairman. Very often the engine that can be overhauled by a poorly trained mechanic is the best design for general use.

Causes of Trouble Not Properly Diagnosed

To appreciate the present-day status of automotive service, one must drive from New York City to San Francisco depending upon the small-town garage for repairs and adjustments. Most of the local mechanics know relatively little about diagnosing the real trouble with a car. Mr. Kettering cited many experiences to indicate how major parts are replaced, engines torn-down, valves ground and special accessories fitted to correct simple faults in operation due to lose terminals, leaky vacuum-tank fittings and similar minor causes. These things are happening in the small centers, not in the large metropolitan service plants. Investigations have revealed the astounding fact that 25 per cent of the cars in the United States are repaired in garages that have dirt floors. This gives some conception of the amount of repair work that must be done in a primitive fashion. Most car-owners know little or nothing about the mechanism of their cars and show no inclination to learn. They depend entirely on the judgment of untrained, uninformed small-town repairmen. Undoubtedly the most general complaint heard from the average owner is that "they had the car three days, charged me $45 and *they did not fix it*." Mr. Kettering believed that one of the most crying needs of service today is for more trained diagnosticians who can put their fingers on the real source of engine or chassis trouble and suggest the simplest means of correcting it.

These conditions show the need for an educational movement to carry reliable and authoritative information to the small-town repairman. Mr. Kettering warned that this would be a long process and that trained mechanics could not be produced by the waving of any magic wand. The industry has been so busy with matters of great urgency during its development stage that comparatively little concerted effort has been put forth to educate mechanics in the towns and villages. However, these men are conscientious and eager to learn. Unfortunately, they have been getting and accepting unreliable advice and information from traveling accessory-salesmen who have been the only representatives of the industry who had direct contact with them in past years. Mr. Kettering said that he had observed on the shelves of small-town garages stocks of spark-plugs, primers, lubricators, carbureting devices, batteries and so-called improvement-fittings, of makes and designs unheard of in standard production. Accepting the salesman's claims as gospel, the garage-man attempts to remedy minor engine ailments by selling these devices and parts to the car-owner at every opportunity. This propaganda of the traveling salesman, who always has a device vastly superior to that fitted on the car as standard equipment, must be combated by concerted and persistent educational campaigns that will place sound, reliable and authoritative information in the hands of the small-town repairman in a form that he can understand and use in his daily work.

Sales Competition Will Raise Service Standards

Mr. Kettering predicted that keen competition for new car sales will have a beneficial effect on service in the next couple of years. Manufacturers will be more receptive to suggestions that are made in the interest of better service. The movement of used cars will be influenced by the character of service rendered by their builders and this will control the sale of new cars to a large extent. Exorbitant cost of repair parts is one of the serious complaints made against present-day service. Mr. Kettering said that keen sales competition will convince the factories that service means more than the sale of repair parts. He emphasized the fact that the high price of small parts, subjected to excessive wear and frequent replacement, is the source of greatest complaint and needs attention first.

N. A. C. C. SERVICE DIVISION PLATFORM

Plan for Future Meetings and Educational Work Approved at the Dayton Meeting

The functions of the Service Division of the National Automobile Chamber of Commerce and some of its definite aims for the near future were set forth in the form of a platform at the Dayton Service Meeting. Some of the more important projects described in the platform are worthy of mention.

The regular November meetings are to be joint meetings with the Society of Automotive Engineers. The November meeting for 1924 will deal with service-engineering topics of interest to sales managers; that of 1925 to production managers, and they will be invited to the meetings. The May meetings, beginning with the one next May, will hereafter be national service congresses, to which will be invited all people interested in service, including, besides factory service folk, representatives of dealers, garages, independent repair-shops, equipment manufacturers, dealer and service associations, automobile schools, trade papers and the public. These meetings will be devoted to talks by prominent men engaged in the various fields of service operation. The object of a national gathering of everyone connected with the servicing of motor cars is to promote unity of thought and action and to build up in the minds of all those engaged the true conception of service and their responsibility to it.

Equipment manufacturers will be invited to exhibit time-saving and garage tools at these congresses, so that dealers and service-station representatives can examine and become familiar with the various tools offered for sale.

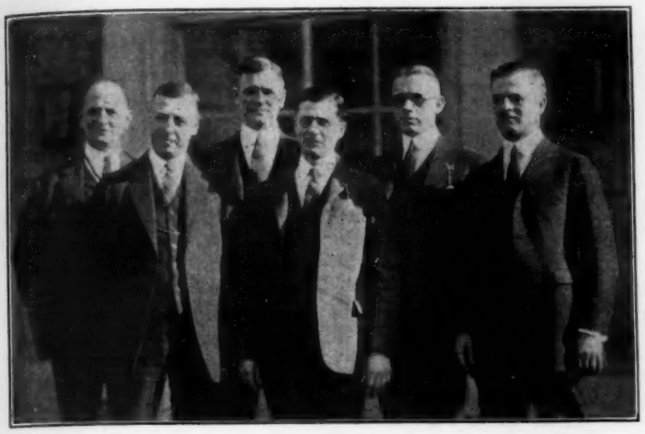
As opportunity offers, the scope and usefulness of the *Service Bulletin* of the National Automobile Chamber of Commerce will be extended, giving it wider distribution. It will be sent to every member of every service association. Effort to educate those who perform service in the field has been made not only in the two ways already mentioned, certain of their representatives being invited to the semi-annual meetings and some being placed on the *Service Bulletin* mailing list, but principally by promoting the establishment and conduct of local service associations in the different cities.

Establishment of Service Associations

This movement has met with some success but in proportion to its merit is far from amounting to what it should and the Division intends to encourage the new and stimulate the old service-associations to renewed activity. To this end it will be necessary to send speakers to address them, this being arranged through a Service Speakers Bureau. There is also in process of compilation a Service Association Manual.

A school for dealers and service associations is contemplated by the National Automobile Chamber of Commerce in cooperation with the National Automobile Dealers Association. This would be an annual affair, lasting 2 weeks. Educational matter is to be circulated among the motoring public through motorists' publications, automobile sections of daily papers and radio broadcasting. This is intended to instruct motorists in the care of their cars.

Men who entered the service field before automobile service schools or courses were available had to learn from the school of experience. It is believed that much can be done for those who have passed the school age and are already



SERVICE COMMITTEE OF THE NATIONAL AUTOMOBILE CHAMBER OF COMMERCE

engaged in service and for those who will enter it without a school course, by laying-out a course of reading graded according to the previous knowledge of the student but calculated to fit both those entering at the lowest rungs and those who have advanced farther up the ladder. Work has been begun on this course by the Division.

DIRT, NOT DILUTION, SCORED

How Excessive Dilution and Sludging of Crankcase Oil Can Be Eliminated

Dilution and sludging of crankcase oil are undoubtedly among the most important phases of the lubrication problem. However, E. F. Hallock, manager of the manufacturers' service division of the Vacuum Oil Co., minimized the *direct* evils of dilution in itself, in his address on The Evils of Crankcase Dilution; How To Educate the Public, and stated that satisfactory lubrication of internal-combustion engines can be maintained with highly diluted oil provided the lubricant be kept free from dirt and other foreign material. He felt that steps should be taken to educate the public in regard to dilution and sludging and suggested that the oil industry would accept gladly its part of the joint responsibility of accomplishing this task.

In connection with the problem of dilution, Mr. Hallock stated that since 1910 the end-point of gasoline sold commercially has been raised from 320 to 438 deg. fahr., this causing greater dilution at present than has ever before prevailed. Among other causes for dilution he mentioned poor mechanical condition of the engine, poor ignition, incorrect timing, improper carbureter adjustment and excessive use of the choke.

Supporting his contention that dilution is only indirectly responsible for lubrication difficulties, the speaker cited the satisfactory use of a mixture of 1 part of cylinder oil to 40 parts of gasoline in two-stroke-cycle marine engines, and a mixture of one in eight in high-speed, air-cooled, two-stroke-cycle engines. He stated that any increased wear resulting from the use of thinned oil is caused directly by the presence of dirt and other foreign matter capable of breaking through the thin-oil film to cause abrasion. Tests were mentioned to show that it is possible to run an engine with diluted oil if the oil be kept clean. With a view to correcting lubrication troubles, frequent drainage was advocated, not because of dilution but because of contamination.

The speaker decried the use of heavy-body oils to solve the dilution problem and claimed that such practice is bound to cause gumming and excessive carbon formation without affecting a cure. Instructions on how to avoid crankcase dilution included the following:

(1) Avoid excessive use of choke
(2) Use radiator cover
(3) Avoid idling for long periods
(4) Keep engine in good mechanical condition
(5) Drain oil-pan every 1000 miles in summer and every 500 miles in winter
(6) Do not flush crankcase with kerosene. Drain crankcase while engine is warm and oil agitated; this will carry off sediment

Emulsification or sludging and corrosion were also discussed at some length. The presence of dirt and water caused by condenser action of the crankcase were given as chief causes for the sludging. Cars used for short runs in city driving were said to suffer most from this trouble. The following items were included in suggested instructions on how to avoid sludging:

(1) Take frequent samples of crankcase oil to detect presence of water in excess
(2) Use suitable radiator-cover
(3) Clean oil-screen after every 100 hr. of service
(4) Select proper fuel. High-test gasoline gives better service
(5) Renew oil frequently and, if sludging has occurred, drop the oil-pan and clean it thoroughly

Mr. Hallock discussed at some length the causes for carbon deposit and acid corrosion. He also suggested means for avoiding excessive trouble from these causes. In conclusion he treated the subject of oil-pumping and gave the following instructions for avoiding oil-pumping and carbon deposit:

(1) Use highest-quality oil
(2) Fill crankcase to proper level daily
(3) Keep engine in good mechanical condition. Do not attempt to rectify mechanical faults by the use of heavier-body oils
(4) Do not try to get higher indications on the oil pressure-gage by adjusting the relief-valve
(5) Be sure that shims are properly fitted to crank-pin
(6) Adjust carbureter properly
(7) Eliminate "missing"
(8) Keep valves properly ground, tappets properly adjusted, and pet-cocks and gaskets tight

FORD SERVICE PRACTICE

Necessity for Standardization of Design and Manufacture Emphasized

Speaking on the subject, What Part the Engineer Can Play in Reducing Repair Costs by Eliminating the Need for Costly Tools, W. A. Francis, manager of the Ford Motor Co. of Cincinnati, brought to bear his experience of a long term of years. He premised his remarks by saying that costly tools will not be eliminated so far as their own price is concerned, the object to be attained being, of course, the reduction of service costs in view of the volume of work to be done. He stressed the importance of simplicity of car construction and of accessibility of all working parts. Yearly changes of models make for incomplete service equipment and result in costly repairs or the installation of expensive tools, placing a burden on the dealers as well as on the users concerned. Standardization looking toward simplicity makes for completely equipped repair-shops, installation of speed tools and the development of highly efficient mechanical ability of the personnel, all this resulting in the reduction of repair cost to the minimum. Complexity of construction means difficulty in locating trouble as well as additional difficulty in eliminating it. Mr. Francis said that Ford dealers could not carry complete stocks of parts if the policy of standardized manufacture were not adhered to. Not many years ago repair-shops in general were poorly equipped, with hand-tools and occasionally with upright drilling machines, emery wheels and the like. The Ford Company has over 9000 sales dealers and their investment in parts amounts to over $50,000,000. Throughout the world, there are 33,000 authorized sales dealers and authorized service dealers. The investigation made several years ago

showed that the average shop for Ford cars could be equipped for $1,500. The cost of repairs is, of course, reduced by low prices for repair parts. It is evident that the qualities of endurance and economy are uppermost in the mind of car-users. They expect efficient service from good local shops.

The price of Ford cars is 20 per cent less than it was in 1914, since which time the items of labor and clerical force have increased 165 per cent.

Every department of the dealer's establishment must function properly and profitably, especially the service department. Large-volume production has resulted in an unparalleled reduction in prices and lower commissions per unit, with an increasing number of "trade-ins." Drastic changes in car models impose a higher rate of depreciation of the market value of automobiles than has occurred in any other line of manufacture; some models have become obsolescent from the sales standpoint in less than a year's time.

Mr. Francis drove home emphatically his point that the engineer can play an important part in the reduction of repair costs by eliminating the need for unduly costly tools, the method for doing this being the standardization of all working parts of motor vehicles.

In the discussion, A. B. Cumner, vice-president of the Autocar Co., said that the tool question cannot be eliminated. He believes that the tools need not be costly and that the engineers are not familiar enough with the tools that are available in the open market for shop equipment, this being evidenced by the fact that, in the design of parts, in many cases holes and lugs have not been provided for the proper use of these tools. He said that, in his opinion, in general procedure efficient repair-shop tools cannot be developed at the factory as the men there are fully occupied on production problems. Many valuable tools have been developed in the field, discarded vehicle parts being utilized in this connection. Mr. Cumner advised strongly that when any change is made on a car, it should be applicable to the prior models. Tool cost can be kept lower in this way. F. A. Bonham, the chairman of the meeting, entered a plea for adequate accessibility of all elements of assemblies that must be reached in repair work. He spoke of one design that required 21 special wrenches.

THE AUTOMOBILE HEAD-LAMP SITUATION

Suggestions for Improvement Are Given by Bureau of Standards

R. E. Carlson, mechanical engineer of the Bureau of Standards, analyzed the head-lamp glare situation before the Dayton Service Meeting. He gave a general picture of present conditions, embracing the work of the Society and the Illuminating Engineering Society, the trend of legislation, and activities of State motor vehicle officials. He also outlined an educational campaign needed to improve conditions and gave an interesting demonstration of a simple method of adjusting head-lamps. He said in part:

Most automobile head-lamps do not give good road illumination because the owner does not know what constitutes a good road illumination or does not have sufficient interest in the subject to have the lights adjusted, or, with the equipment on the car, good light is impossible of attainment. Better head-lamp equipment is being furnished with the newer cars but the millions of older cars in use must be considered. The reflectors are often dirty, tarnished or rusted, the focusing device is cumbersome to operate, may not allow focusing with newer types of bulb, and will not stay put, and aiming or tilting of head-lamps is a very hard and often impracticable job. To improve this condition the sale of uptodate replacement units should be pushed.

To obtain data on local conditions in the City of Washington, the Bureau of Standards conducted a test lasting over a week on some 400 cars built by 56 motor-car companies. A number of new cars were included. The results obtained are summarized in the accompanying table.

RESUME OF HEAD-LAMP TESTS GIVING THE PERCENTAGE OF CARS HAVING HEAD-LAMPS IN THE CONDITION NOTED

	Per Cent
Equipment in Good Condition	5.5
Lenses	
Dirty	52.8
Broken	4.3
Loose in Head-Lamp	3.8
Twisted in Head-Lamp	35.8
Reflectors	
Dirty	38.8
Rusty	6.7
Dented	1.7
Bulbs	
Out of Focus	73.2
Blackened	5.3
Too High Candlepower	0.5
Too Low Candlepower	6.7
Head-Lamps	
Not Parallel	23.6
Not Correctly Tilted	46.7
No Outside Focus Adjustment	8.4
Glaring Lights	54.0

Particular attention is directed to the large number of cars with lights out-of-focus, 73.2 per cent of the total. This means not only glare and its attendant danger and discomfort to other motorists and pedestrians, but inadequate roadlight with the consequent element of hazard.

Trend of Legislation

The California motor-vehicle law of 1923 will serve as an example of the detailed requirements now being incorporated in State laws. The following are some of the important points:

(1) Sufficient light to render clearly discernible a person, vehicle, or substantial object 200 ft. ahead

(2) Device shall be constructed, arranged and adjusted so as to give a beam complying with the specifications of the law

(3) Head-lamp devices must be tested and approved before their use shall be lawful. Fifty dollars' fee with application for test

(4) Details of test specified; similar to those of Illuminating Engineering Society's and Society of Automotive Engineers' requirements

(5) If arrested for improperly focused lights, owner will be released if head-lamps are adjusted within 24 hr.

(6) Unlawful to sell a device unless it is ap-

R. N. Falge

R. E. Carlson

proved and accompanied by a complete description and instructions for use, including photographs of the device and the beam pattern on a chart

In an effort to promote uniformity of enforcement of the State laws, responsible State officials of Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont have formed what is known as the Conference of Motor Vehicle Administrators. A special committee of this conference passes on matters pertaining to head-lamps. Other conferences should be established throughout the Country so that the benefits of this sort of cooperation can be enjoyed more widely.

EDUCATIONAL CAMPAIGN

Provision has been made for the testing and approval of head-lamp devices, efforts are being made by head-lamp manufacturers and engineering societies to improve the quality of and simplify the service required for these devices, and certain State authorities have been and are making serious efforts to have these devices adjusted by motorists. In spite of all this, the great majority of motorists are not adjusting their head-lamps. To focus interest and to secure action on this subject, a national campaign of education has been started to supplement the work already under way.

The work of the enforcement officer is of particular importance. He must understand that bright head-lamps are not necessarily blinding. It is fatal to the success of this movement to require the motorist to dim his lights; dimming when an officer is in sight will not improve lights that may be badly out of adjustment. A better method of enforcement is to require the motorist to adjust his lights within a specified time and report back to the officer with a ticket certifying that the lights have been adjusted.

From an analysis of some 400 fatal accidents last year in Massachusetts it was found that, where head-lights were concerned, 2½ were due to insufficient light to every 1 caused by too bright light. Dimming is a mistaken idea of courtesy. The human eye, marvelous as it is, cannot adapt itself instantly to such a violent change of light intensity as results from dimming. "Don't Dim, Adjust your Headlights."

CAR BUILDERS' RESPONSIBILITY

Responsibility of the car builder should not cease until the new or reconditioned car is delivered to the owner with good head-lamps and the owner understands how to keep them in good adjustment. Letters written to some 50 car producers indicate a great variation in practice on this point, some companies apparently trusting to Providence that the lights adjusted at the factory will still be good when finally turned over to the buyer. Others have provided the machinery for close supervision of head-lamps through their service departments, branches, dealers and garages. These companies deserve the highest praise.

Car builders should furnish adequate but simple instructions for adjustment, preferably using photographs of beam patterns. These directions should be included in instruction-books, service publications and other mediums. Uniform instructions for all cars should be worked out so that the average garage mechanic will have no trouble in adjusting the head-lamps on any car. Factories must spend more money for good head-lamp equipment. Money invested for higher-grade equipment will return a dividend in the reduced cost of service.

R. N. Falge, of the National Lamp Works, and C. A. Michel, of the Guide Lamp Co., spoke briefly after Mr. Carlson's paper. They both said that head-lamp equipment has been improved greatly due to the agitation for better road illumination in the past 6 months.

CHARTING OF SERVICE DATA

Methods for Making Service Information Most Useful to Designer Explained

O. T. KREUSSER

It has been demonstrated that the trend of the automobile industry should be toward the production of better-performing cars at a decreasing over-all cost per mile of transportation. Upon these factors the continued growth of the industry is founded.

One of the essential items in this conception, as brought out by O. T. Kreusser in his address on Providing the Engineer with Service Data To Improve Design, is a satisfactory maintenance service. Such a service means contented users, and hence a greater volume of business for the factory. But the maximum of advantages can never accrue to the car-user without the closest cooperation between the field and the factory; by this means a rational basis for improved design and construction can be made available. To this end an effective means of communication must always be maintained between those in the field and those at the factory. In his address Mr. Kreusser advocated the closest possible contact between the two branches and suggested a simple form of chart for use in plotting the car troubles as they are brought to the service department. The object of the system is to present to the factory engineers danger signals of repeated troubles with certain features of the cars considered.

A chart of this type, as used by the General Motors Research Corporation, was shown by Mr. Kreusser. It was divided into a total of about 125 headings and sub-headings, with a space opposite each item where dots could be placed to indicate the occurrence of the trouble, the idea being to show, not the specific fault, but merely the frequency with which a fault became apparent in a given element in number of cars observed. The following items were included in the chart.

Engine
- Stationary members
- Moving members
- Lubricating system
- Valves
- Induction and exhaust system
- Cooling system

Electrical
- Generating
- Storing
- Starting
- Ignition
- Lighting and signaling
- Wiring

Clutch and Transmission
- Clutch
- Transmission operation
- Propeller-shaft
- Rear-axle operation

Running-gear
- Running-gear
- Frame
- Springs
- Steering
- Braking
- Instruments

Body
Body
Top
Metal

The example cited showed results of 25,000-mile tests conducted by the General Motors Corporation on a number of cars of different makes operated under as nearly identical conditions as possible. The occurrence of faults in each item was indicated by a corresponding number of dots properly placed in the block to show the time during the test-period when the difficulty arose. In such an analysis danger signals are obvious and steps can be taken to remedy the faults. It was pointed out that the design improvements indicated by such a chart do not always coincide with those that would be selected by an engineer who did not have access to such a pictorial summary.

Mr. Kreusser suggested that factory service departments furnish their field stations with charts of some description in order that pertinent information, from the best of sources, can be made available to the plant engineers for their use in modifying features of design when necessary.

In the discussion it was stated that reliable information is difficult to obtain from field service-stations. A. J. Scaife, of the White Motor Co. reported that his company had considered it advisable to send a staff of engineers into the field to collect required dependable data. He said that in his experience about 5 out of each 500 reports supplied by regular service-men had been of practical value.

It also developed during the discussion that cooperation between the factory engineering and the service department is not by any means always lacking. B. B. Bachman, of the Autocar Co., outlined the plan of that company for getting service-men in from the field at frequent intervals for conference with the factory engineers. He stated that this practice of discussing important problems is productive of much good.

FLAT-RATE SYSTEM ADVOCATED

Improvements in Design to Reduce Maintenance Costs Suggested

DON T. HASTINGS

In outlining the various steps involved in the general problem of automobile design, construction and maintenance, Don T. Hastings, of Williams & Hastings, Inc., Detroit, stated that certain factors of original design, such as tire-size, wheelbase and weight, are determined by the prices of finished models fixed by factory executives; while other items, such as gear-ratio and engine-power, are settled by competitive conditions applying to cars of the same price-class.

In the original lay-out of a car, it is the duty of the engineer to apportion suitable percentages of the total car-cost to the various items involved. In this process the maintenance allowance often becomes inadequate to finance properly the most advantageous treatment of maintenance features. Thus a saving in first cost is made at the expense of upkeep. This was given by Mr. Hasings as one of the reasons why certain designs have been seriously at fault from the maintenance point of view. As an example of this, he cited the use of a two-piece malleable-iron rear-axle housing, whereas a pressed-steel housing with suitable shafts would be much superior from the service standpoint, although more expensive in first cost. He also mentioned the reduction in service costs made possible by providing valve-rods and tappets in clusters, by eliminating such features as the full-length sod-pan and by making parts accessible for adjustment or replacement. The use of oversize parts was advocated for installation after wear of bearings in service.

Referring to accessibility and to the common lack of this desirable feature, the speaker recalled an instance where the main bearings could not be adjusted without removing the engine from the frame. Slight changes in design would have remedied the defect, reducing the cost of service greatly. In another car it was impossible to bring the pistons down past the crankshaft, while in a third that was subsequently altered the tappets could not be adjusted without the removal of the vacuum-tank, the carbureter and the manifold.

In concluding his address, Mr. Hastings mentioned the possibilities of reducing maintenance charges by the systematic conduct of the servicing business; this including the keeping of suitable records, the use of the flat-rate system, the economical use of floor space and equipment and the elimination of labor losses due to idleness.

The discussion following this address served to bring out more clearly several of the more important points. All agreed that the use of the flat-rate system should be extended and that the coordination of the several engineering branches of the industry is essential to the most satisfactory functioning. It was suggested that this could be brought about by a closer study of the problems of each department by the members of other departments.

SERVICE THE BIG BROTHER OF SALES

Modern Service Methods Outlined; Training Course for Service Men Described

Selling of service is the real business of an organization, according to W. L. Wise, service manager of the National Cash Register Co., who spoke on the subject of Service. Furthermore, it was the speaker's belief that a company becomes just as big or just as small as the individual service-man. This conception clearly emphasizes the importance of training service-men so that they themselves are sold on the features that they in turn are expected to sell. For, unless they believe the service to be good and the product worthwhile, their chances of convincing others are exceedingly small. It is with these points in mind that the National Cash Register Co. has developed very carefully a system of education and training for the men who act as points of contact between the factory and the users.

Approximately half of this training is mechanical, the other half being devoted to the proper sale of the service. The object of the latter is to instill the idea into the man and then instruct him as to the best methods of passing on his convictions to the users. Efforts are made to assure the service-men of the company's interest and backing. Furthermore, he is impressed with the idea that his own activities have a direct bearing upon the future progress of the company; that is, that he is capable of making or breaking his company's reputation throughout the territory in which he operates. Thus, he is taught to think well and to speak well of his product and to take pride in its betterment by giving to the company any helpful suggestions that may occur to him.

On the other hand, the company endeavors to show the customer that it is proud of the service and of the men who administer it; such pride should result only from a real desire and effort to bring about the condition of highest satisfaction to the user.

The fact that the company sets the price for the repair-man's work is invariably passed on to the customer. The prices per hour include the cost of necessary tools. Before a job is undertaken an inspection is made and an estimate of the cost is figured. No elaborate overhaul is attempted without the customer's consent.

It was contended that the expenditure of considerable sums for better service and for the promotion of a closer feeling

of understanding among factory, repairman and customer was amply justified on a basis of business returns.

In conclusion, Mr. Wise summarized as follows the items that a service-man has to sell:

(1) The company and its product
(2) The reasonableness of the guarantee
(3) The necessity for the repair job according to the company's standard
(4) The use of the company's parts
(5) His price
(6) The need for having the machine cared for periodically
(7) The proper use and the avoidance of abuse
(8) The manufacturer's service
(9) Most important, the fact that the service-station is being run for the benefit of and in appreciation of users and not as a means of deriving additional income from them

In illustrating the many interesting points of his address, Mr. Wise showed samples of instruction material, advertising literature and service information forms which are used by his company in maintaining its service department.

ELECTRICAL EQUIPMENT PROBLEMS

Frank Discussion of Conditions Existing in the Field That Should Be Remedied

P. J. DURHAM

One of the most important sessions of the meeting was that at which P. J. Durham, secretary of the Automotive Electric Service Association, and J. W. Tracy, general manager of the North East Electric Co., presented their views on the reasons for, the particularly aggravating points of and possible ways of remedying the unsatisfactory conditions prevalent in the installation and maintenance of electrical equipment of passenger cars. Chairman Bonham introduced the speakers by saying that the problem involved is a tremendous one and worthy of careful thought.

Mr. Durham, who has been engaged for many years in the maintenance of electrical equipment in the field, said that, whereas some repairs can be accomplished easily, those that must be made when the cars are relatively new are peculiarly disturbing to the owners and the repairmen. He agreed in the general opinion that the principal cause of the trouble is "purchasing department engineering," an expression used by W. A. Chryst at the meeting to indicate that too frequently the electrical equipment manufacturers are held down unduly in the matter of the price that will be paid for the articles they produce.

Mr. Durham pointed to the fact that the average man, even though he be familiar with automobile engineering in general, will hesitate to attempt to diagnose an electrical ailment of a car. Of course, much is involved in the work that is beyond the ability of the average mechanic. Headlamp doors are difficult to remove, it taking hours sometimes to install a 30-cent bulb. Focusing devices become rusted to such an extent as to make them useless. Many reflectors are not what they should be, lenses are not held in fixed positions and in many cases no method is provided in the equipment for aiming the lights. In too many cases it is impossible to make an adjustment that will last long. Head-lamps must be made better and more easily repairable and adjustable.

The speaker referred especially to the poor quality of electrical contacts and the absurdly small screws used in electrical equipment. The terminals of switches, for example, should be not only better but accessible. At the present time, reaching and adjusting switch connections involves physical contortion by the operator in the case of the average car. This sort of thing causes unnecessarily large labor charges. The screws should be at least as large as No. 12 size and be made of brass instead of iron. Poor contact at an ammeter may involve almost endless expensive troubles in various parts of the electrical equipment. Fuses and fuse clips are too flimsy and too small, as well as difficult to remove. In moderate-priced cars the wiring installment is poor, the wires being generally secured at the terminals only. In this connection Mr. Durham said that a standard code of colors for wires would be of great value in locating and remedying circuit troubles. The storage-battery is the source of the greatest annoyance to service-men. Terminals of generous size would aid greatly and better accessibility is needed. Too many types of terminals are used. At the present time the keeping of a stock for battery service involves considerable investment, if slow-moving special sizes are included. In Mr. Durham's opinion, battery containers should be made larger as a general thing, as there is no doubt that the owner will be benefited in many cases by purchasing a larger battery than that furnished with his car. The shape and the design of the generators have been changed so much that in practice the temporary repair of generators has become almost impossible. For this reason the investment required to maintain a rental service is formidable in amount. In many cases inaccessibility of the generator mounting causes too high labor-charges. As a whole, the generator is the most difficult element encountered in the servicing of electrical equipment.

With reference to the whole problem, Mr. Durham said that, to minimize the amount of required repairs, it will be necessary to improve the design of, materials for and workmanship of electrical equipment. He feels that electrical connectors of the detachable type are unnecessary on headlamps, as the latter are rarely removed from the car. These connectors cause annoyance because they are small, hard to manipulate and inaccurate. The electrical connections between the wire and the connector and between the plug and the socket are not sufficiently dependable. A better form of connector or splice should be provided and installed under the hood or inside of the head-lamp. Trivial troubles stall cars. Generators have had to be reconditioned simply because of flimsy connections in the charging line.

Mr. Tracy explained the conditions that surrounded the original installation of electrical starting and lighting units on cars many years ago. Little time was available for redesigning engines and chassis for accommodating this equipment, and therefore the servicing of the parts involved was handicapped from the start. Room for improvement in this respect still exists. Odd and unusual sizes and shapes of bolts, nuts and screws must give way to practicable commercial standards. Intricate operations and complicated circuits will have to be simplified and the repairing of the equipment with simple tools fully considered fundamentally in the design of the apparatus. Increased labor-charges for repairs due to the unsatisfactory performance of inadequate equipment should not be tolerated. The battery is often dismissed by the car-maker with slight consideration. A labor cost of $6 is sometimes involved in installing a 6-cent brush on a generator. In some cases the radiator must be removed in this operation. A repair-parts stock at the present time includes over 1000 different types of electrical equipment. One electrical manufacturer has over 400 different armatures to service, these being characterized by very minor differences. Changes should be avoided when possible; and when they have to be made they should not interfere with interchangeability. Satisfactory service cannot be had in the field if the field is compelled to serve as a "laboratory." At the present time many service-stations are carrying obsolete parts. The designing engineer can be most effective by studying the conditions the field men encounter and cooperating fully with these men. Design of new apparatus and changes in design

can be benefited in every instance by a study of service department experience. A minor change in the size or shape of a device may call for radical changes in the testing equipment throughout the whole field of the service organizations.

A. H. Packer, who presented at the Service Meeting of the Society held in Chicago last February a paper relating to the general problem discussed at this meeting, reiterated his opinion that not enough attention has been paid to the men who are endeavoring to give service in the towns and small cities throughout the Country. Mr. Cumner said that no trouble will be encountered with the wiring system in motor vehicles if proper installation is made in the first place.

Chairman Bonham recommended that various units of electrical equipment be designed so that they cannot be assembled on a car in any way except the right way and agreed that the best efforts of all concerned should be exerted to assist the users and repairmen in the "hick" towns, as expressed by Mr. Kettering, inasmuch as 65 per cent of the product of the automobile factories is purchased by people residing in or near the small cities and towns of this Country.

FLAT-RATES HELPFUL

Engineering Cooperation Urged for the Success of the Flat-Rate Service

J. W. Lord

In a paper entitled Ways in Which the Engineer Can Cooperate To Make Flat-Rate Service More Successful, J. Willard Lord, service manager of the Harrolds Motor Car Co., called attention to the importance of the automobile maintenance industry and stated that service and maintenance establishments are being conducted more and more along modern, straightforward and honest business lines. As an evidence of such improvement he cited the introduction of flat-rate charges for repairs and the establishment of shop standards for measuring the performance of mechanics. With reference to effecting even greater improvement, he expressed the belief that the coordination of engineering with service is bound to lead to the production of vehicles that will give greater satisfaction to the buying public than ever will be possible under the general conditions of largely dissociated engineering effort existing today.

Mr. Lord suggested that engineers cooperate with the service-men, in their endeavor to reduce maintenance charges, by giving consideration at the time of designing the vehicle to (*a*) tools for repair work, (*b*) degree of accessibility as an aid to repair and (*c*) facility of removal and replacement of units. He recommended the holding of service conventions at the factories to stress the matter of repair tools, and urged the application of engineering thought to the production of parts.

PNEUMATIC SHOCK ABSORPTION

Detroit Section to Hear Paper on Device Using Air as Shock-Absorbing Medium

Slides will illustrate the paper on Shock Absorbers which J. M. McElroy, chief engineer of the Westinghouse Air Spring Co., will present before the Detroit Section at its technical session on Dec. 6.

Mr. McElroy will cover the patent history and early development of the device before going on to a discussion of the present suspension and what it does theoretically. Axle movement, with and without the air spring, will be taken up next, followed by a study of the relation of axle movement to riding comfort. Mr. McElroy's paper will also include a thorough treatment of the design, manufacture, installation and servicing of the air spring.

The Dec. 6 meeting of the Detroit Section will be held, as usual, in the General Motors Building at 8 o'clock, preceded by a dinner at 6:30 p. m.

CRANKCASE IMPROVEMENTS ADVOCATED

Accessible Oil-Drain and Other Design Changes Urged at Dayton Service Meeting

T. A. Waerner

In discussing the subject, What the Engineer Can Do To Help the Public, T. A. Waerner, engineer with the Tide Water Oil Co., treated the matter of crankcase-oil dilution and mentioned three points to be considered by engineers for bringing about improvement in this regard. These points relate to design and are as follows: (*a*) suitable location of oil-drain; (*b*) arrangement of parts to facilitate cleaning them after the oil has been drained; (*c*) the design of crankcase oil-sump to reduce dilution.

Mr. Waerner emphasized the necessity for draining the crankcase in both summer and winter at frequent intervals and argued that this operation would be conducted more frequently if cars were designed so as to make it less difficult to accomplish. Calling attention to the decision of the Standards Committee of the Society that no definite type of oil-drain should be standardized but that a suitable oil-drain of ample dimensions, operable from a point under the hood, should be installed, he stated that very few factories produce cars whose engines are so equipped.

As a universal practice in all designs, consideration was urged of the arrangement of the oil-pump screen in such a way as to make possible the removal of the screen independently of the oil-pan. Mr. Waerner took up in some detail the process of combustion as affected by the structure of various types of gasoline and entered into a discussion of the factors responsible for crankcase dilution and its damaging effects on engines. He called attention to the incongruity of the variety of crankcase capacities, these ranging from 4 to 14 qt., and recommended standardizing on two capacities, one measure for four-cylinder engines and the other for six and eight-cylinder engines.

ANNUAL MEETING IN DETROIT

Arrangements Presage Extensive Program and Large Attendance

Arrangements for the Annual Meeting in Detroit, Jan. 22 to 25, are progressing rapidly and a number of the preliminary details can be announced at this time. It is planned to make the program of papers the most comprehensive of any meeting ever held by the Society. This will necessitate the scheduling of simultaneous sessions, but the topics will be arranged so that very little conflict will occur between papers on related subjects that are of direct interest to special groups of the membership. All sessions will be held in the massive building of the General Motors Cor-

poration. Morning meetings will be held in the auditorium which is capable of seating 1100 persons. Papers of general interest will be given at these morning sessions and it is probable that no meetings will be run simultaneously with them. Afternoon and evening sessions will be held in quarters on the 15th floor of the General Motors Building, these being provided through the courtesy of the General Motors Corporation. Facilities are available in the building for telegraphic service, purchase of railroad transportation and the serving of excellent cafeteria meals. It is unlikely that any better place could have been chosen for the Annual Meeting anywhere in the Country.

Committee Organization

Mason P. Rumney, chairman of the Meetings Committee of the Society, has chosen several sub-committees of the general committee to assist in making the arrangements for this big undertaking. The personnel of the committees so far appointed is as follows:

ENGINE, FUEL AND CHASSIS PROGRAM

Thomas J. Litle, Jr., *Chairman*

L. C. Freeman
George L. McCain
W. R. Strickland
J. G. Vincent
F. E. Watts

PRODUCTION PROGRAM

K. L. Herrmann, *Chairman*

Committee being organized

AERONAUTICAL PROGRAM

Prof. E. P. Warner, *Chairman*

Committee being organized

TRUCK AND BUS PROGRAM

F. C. Horner, *Chairman*

Committee being organized

BODY ENGINEERING PROGRAM

A. L. Knapp, *Chairman*

Dean Baskerville
A. A. Cripps
William Davis
A. J. Fisher
Kingston Forbes
Otto Graebner
W. H. Jones
R. A. LaBarre
J. W. Votypka
J. F. Wilson

Each of these committees will be responsible for the program of papers given in its respective field. All committees are now functioning and the program is practically closed. A special issue of the *Meetings Bulletin* will reach the members about Dec. 15 and this will contain the tentative program. Present plans call for four sessions on engines, fuels and chassis; three body meetings are scheduled; aeronautical subjects will require two sessions; two meetings will be devoted to trucks and buses; and at least two production meetings will be held.

Subjects of Annual Meeting Papers

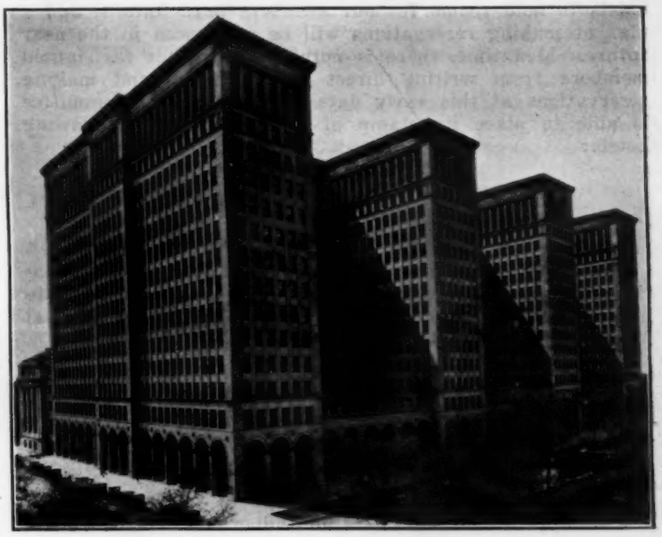
Present plans as contemplated by the several committees on papers call for discussion of the following subjects:

Engine, Fuel and Chassis

- Steam cooling systems
- Radiator design
- Carbureter characteristics
- Anti-knock fuels
- Detonation control
- Crankcase-oil dilution and engine wear
- Brake testing
- Constant-compression engines
- Air-cleaners
- Manifold design
- Fuel volatility

Aeronautics

- Design of the Shenandoah (ZR-1)
- Engine design for reliability
- Research work of the National Advisory Committee for Aeronautics



General Motors Building, Detroit, Where the 1924 Annual Meeting Will Be Held

- Design of commercial aircraft
- Operating experience of the Postal Service

Truck and Motorbus

- Motorbus and railroad transport coordination
- Operation of urban and interurban motorbus systems
- Motorbus transportation and its relation to traffic

Body Engineering

- Nickel plating
- Black enameling on non-ferrous metals
- Upholstery fabrics and styles
- Casein glues
- New body constructions
- Detrimental effects of accelerated drying

Subjects for the production meetings have not been selected as yet. A large number of car and parts companies are being asked for papers on manufacturing problems and the program is certain to be of interest to factory men.

Standards Committee Meeting

Many important recommendations will be voted on by the Standards Committee at its annual meeting which will be held in Detroit on Tuesday, Jan. 22. This meeting will open the activities of the 4-day gathering of the Society.

It is probable that the Annual Business Meeting and election of officers will be scheduled for Tuesday evening, Jan. 22. This meeting is expected to be a very important one because of the probability of there being a general discussion of relations between the parent Society and the Sections. Following the conclusions of the business program and the address of President Alden, a representative of the Ordnance Department of the United States Army will present an illustrated talk on the remarkable development of ordnance materiel, both general and automotive, that has been accomplished in the past year or two.

Reduced Railroad Fares

It will be possible for members of the Society to secure reduced railroad-fares to the Annual Meeting in Detroit. The plan will operate the same as that used at past Annual Meetings and will entitle members using the proper certificates to buy return tickets from Detroit to their homes at half-price. Complete details of this reduced-fare plan will be published in the *Meetings Bulletin* and in the January issue of The Journal.

It is not too soon to warn members that hotel facilities in Detroit will be taxed during the week of the Annual Meeting. Detroit's Automobile Show will be in progress during the meeting period and will attract many people to the city. Arrangements are being made with some of the

hotels to hold rooms for our members until Jan. 1, and a plan of making reservations will be announced in the near future. Meantime, there is nothing to prevent far-sighted members from writing direct to the hotels and making reservations at this early date. The Meetings Committee is able to place its stamp of approval on the following hotels:

Hotel Statler
Hotel Tuller
Wolverine Hotel
Fort Shelby Hotel

The Hotel Statler has set aside a part of its accommodations for Society members so that it is advisable to state in your letters to them that you will attend the Annual Meeting of the Society.

GAY CARNIVAL IN DETROIT

Famous Social Function Revived as the Entertainment Feature of Meeting

Worshippers of Terpsichore and adherents of syncopation and gay revelry will listen with tinkling enthusiasm to the announcement that the Society's Carnival has been revived! At the October meeting of the Council, the Meetings Committee made the suggestion that this popular social event be scheduled as the entertainment feature of the Annual Meeting in Detroit in January. Approval was given by the Council and the following large committee of Detroit enthusiasts is now busily laying plans for one of the finest social gatherings ever held by the Society.

1924 CARNIVAL COMMITTEE

George H. Hunt, *Chairman*

Fred A. Cornell	G. E. Goddard
V. C. Cramer	B. G. Koether
W. P. Culver	W. C. Little
H. T. Ewald	Neil McMillan, Jr.
R. K. Floyd	M. P. Rumney

Oriole Terrace, Detroit's largest and finest dine-and-dance establishment, has been chartered for the night of Jan. 23 for this great party. It will accommodate 750 people, the music will be strummed and syncopated by an unusually fine orchestra headed by a gentleman named Theis, whose abilities have just about captured all of the fox-trotters in the Motor City.

An innovation is planned in connection with the 1924 Carnival; all present will be seated at reserved tables as in the usual dinner-dance establishment. Applications for tables will be included with the issue of the *Meetings Bulletin* to be mailed about Dec. 15 and reservations will be made in the order of receipt, the better table locations going to the early comers. Moral: Send yours in promptly.

ANNUAL DINNER AT HOTEL ASTOR

A. G. BERGMANN

Transferring the Annual Meeting to Detroit will not affect that great institution, the Annual Dinner. This important event will be held at the Hotel Astor, Thursday evening, Jan. 10, starting at 6:30 o'clock. A. C. Bergmann has been appointed chairman of the committee that will be in charge. He promises to create an unusually fine atmosphere of good fellowship. Special care will be taken to see that folks get acquainted and have an enjoyable evening.

As announced in the last *Meetings Bulletin*, the Society has been successful in securing E. S. Jordan, more intimately known as "Ned," as toastmaster for this occasion. Those who know Ned Jordan and have enjoyed his genial humor and sound sales logic will appreciate that the work of the helmsman will be handled satisfactorily.

Only two speakers will be on the program. We are fortunate in having secured Dr. M. L. Burton, president of the University of Michigan, a speaker noted for his forcefulness, interesting personality and his ability to leave a message that men will think about long after the day of his address. He has chosen as his subject That Mind of Yours. You may be sure that he will tell you some things about it that will make you have a greater respect for the important problems facing the world today and your responsibility in being fit to solve them.

Although we have received the tentative acceptance of another speaker, whose high standing as an authority on commerce and a statesman is internationally acknowledged, it is impossible to make any definite announcement until a later date, owing to the fact that his engagements with national affairs might cause an unexpected interference.

Dinner ticket applications will be included with the next issue of the *Meetings Bulletin*, reaching the members about Dec. 15. Seats will be reserved in the order of receipt of these applications, preference as to location being accorded the early comers.

Applicants *for* Membership

The applications for membership received between Oct. 15 and Nov. 15, 1923, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

AKRON-SELLE CO., *Akron, Ohio.*

ANDERSON, M. C., engineer, Lee Trailer & Body Co., *Chicago.*

ANDERSON, O. L., layout draftsman, Rickenbacker Motor Co., *Detroit.*

AYERS, DONALD J., chief engineer, Anthony Co., *Streator, Ill.*

BABINGTON, ALFRED EDWARD WILFRED, automobile broker, 436 Yonge Street, *Toronto, Ont., Canada.*

BARNETT, JOHN H., advertising manager, Robert H. Hassler, Inc., *Indianapolis.*

BEST, FRANCIS CLARENCE, chassis draftsman, Packard Motor Car Co., *Detroit.*

BITZER, HARPER G., student, Ohio State University, *Columbus, Ohio.*

BLACKMAN, EDWARD C., assistant in experimental department, American-La France Fire Engine Co., *Elmira, N. Y.*

BROOKS, MELVIN S., Ford Motor Co. of Canada, Ltd., *Ford, Ont., Canada.*

BRYAN, HARRY F., carbureter engineer, Ensign Carburetor Co., *Los Angeles.*

BRYSON, WILLIAM R., designer, Rickenbacker Motor Co., *Detroit.*

CAIN, JOSEPH I., student, University of Illinois, *Urbana, Ill.*

CARLSON, CLIFFORD E., chemist, Remington Arms Co., *Ilion, N. Y.*

COURTNEY, HARRY V., student, Stevens Institute of Technology, *Hoboken, N. J.*

CRAWFORD, JOSEPH T., manager of automobile sheet department, American Rolling Mill Co., *Middletown, Ohio.*

CUNNINGHAM, JOHN HUNTER, chief engineer and designer, W. H. Dorman & Co., Ltd., *Stafford, England.*

FEZANDIE, EUGENE, instructor, Stevens Institute of Technology, *Hoboken, N. J.*

FORS, ARTHUR R., production engineer, Continental Motors Corporation, *Detroit.*

FULLER, WAYNE R., manager of industrial sales, Pratt & Lambert, Inc., *Buffalo.*

GAUTHIER, DONAT A., assistant mechanical superintendent, Ottawa Car Mfg. Co., *Ottawa, Ont., Canada.*

GOODIER, HOMER WADSWORTH, mechanical engineer, Atmospheric Nitrogen Corporation, *Syracuse, N. Y.*

GRANGER, HENRY R., student, Cornell University, *Ithaca, N. Y.*

HALL, FRED A., draftsman, Yellow Coach Mfg. Co., *Chicago.*

HALLIBURTON, VIRGIL FRANCIS, student, Massachusetts Institute of Technology, *Cambridge, Mass.*

HEINTZ, LEO I., president, Heintz Mfg. Co., *Philadelphia.*

HOWARD, H. F., manager of service department, Wire Wheel Corporation of America, *Buffalo.*

JACKMAN, CHESTER C., works manager, Stanley Motor Carriage Co., *Newton, Mass.*

JACOBS, W. T., chief engineer, Stephens Motor Car Co., *Freeport, Ill.*

KRIETER, HARRY R., student, University of Michigan, *Ann Arbor, Mich.*

LIDDLE, GEORGE D., student, Ohio State University, *Columbus, Ohio.*

MILLER, JOHN H., superintendent, International Motor Co., *Allentown, Pa.*

MOORE, HAROLD M., student, Ohio State University, *Columbus, Ohio.*

MORRIS, C. A., manager and proprietor, Morris Motor Car Co., *Waterloo, Iowa.*

NAGLE, L. S., sales engineer, Pacific coast division, Hyatt Roller Bearing Co., *San Francisco.*

NEWMAN, ALEXANDER, student, Armour Institute of Technology, *Chicago.*

OSWALT, ELMER J., student, Ohio State University, *Columbus, Ohio.*

PEARLSTONE, PAUL, student, Sheffield Scientific School, *New Haven, Conn.*

PERESUTTI, LUIS, student, Ohio State University, *Columbus, Ohio.*

QUIMBY, GEORGE WILLIS, automobile body engineer, Fox Motor Car Co., *Philadelphia.*

RALLS, GEORGE H., sales manager, Gabriel Mfg. Co., *Cleveland.*

RITTER, RALPH B., mechanical engineer, A. O. Smith Corporation, *Milwaukee.*

SAGE, FRED L., engineer, Mason Motor Truck Co., *Flint, Mich.*

SCHERMERHORN, CHARLES B., student, University of Michigan, *Ann Arbor, Mich.*

SIMPSON, ANDREW, instructor, Swarthmore College, *Swarthmore, Pa.*

SIMPSON, THERON B., assistant tool engineer, Motor Wheel Corporation, *Lansing, Mich.*

SKLENAR, FRED H., draftsman, Beneke & Kropf Mfg. Co., *Chicago.*

SMILLIE, CHARLES M., JR., efficiency and methods engineer, Ternstedt Mfg. Co., *Detroit.*

STARING, W. H., vice-president, Perfection Heater & Mfg. Co., *Cleveland.*

STILLE, ERNST H., draftsman, Sayers & Scovill Co., *Cincinnati.*

SWANSON, VERNER J., chief engineer, A. L. Powell Power Co., Inc., *Cleveland.*

TIBBETS, FRED H., JR., student, Ohio State University, *Columbus, Ohio.*

TRUSCOTT, PERCY J., teacher, Arthur Hill Trade School, *Saginaw, W. S., Mich.*

TYLER, RALPH H., general superintendent, Herbrand Co., *Fremont, Ohio.*

VANDERWALL, THEODORE, engineer, C. M. Hall Lamp Co., *Kenosha, Wis.*

VARADY, JOHN C., student Ohio State University, *Columbus, Ohio.*

VIGMOSTAD, TRYGVE, body engineer, Stephens Motor Car Co., *Freeport, Ill.*

WATERS, MAURICE W., clerk in traffic department, Detroit, Toledo & Ironton Railroad Co., *Detroit.*

WILLIAMS, RICHARD C., sales engineer, E. I. duPont de Nemours & Co., *Parlin, N. J.*

WILLITS, S. R., sales engineer, Beneke & Kropf Mfg. Co., *Chicago.*

WILSON, FRANK E., student, Ohio State University, *Columbus, Ohio.*

WOODWARD, IRVING C., mechanical engineer, Prest Barty Axle Corporation, *Syracuse, N. Y.*

WRIGHT, PAUL D., student, Ohio State University, *Columbus, Ohio*

Applicants *Qualified*

The following applicants have qualified for admission to the Society between Oct. 10 and Nov. 10, 1923. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (S M) Service Member; (F M) Foreign Member; (E S) Enrolled Student.

ARNOLD, CHARLES F. (E S) student, University of Cincinnati, *Cincinnati*, (mail) 52 Piquette Street.

BITZER, HARPER G. (E S) student, Ohio State University, *Columbus, Ohio*, (mail) 635 Seymour Avenue.

BLACKBURN, ROBERT HICKMAN (A) owner, Blackburn Oil Co., *Spartanburg, S. C.*, (mail) P. O. Box 51.

BLEIWEISS, M. (A) branch manager, Templar Motors Co., Cleveland, (mail) 1253 Webb Road, *Lakewood, Ohio.*

BOSSI, ENEA (M) engineer, Self-Feeding Vaporizer Corporation, 1737 Broadway, *New York City.*

BROGAN, G. W. (A) advertising manager, Black & Decker Mfg. Co., *Towson, Md.*

BRYANT, WILFRED ROBERT (A) engineer, Hole & Bryant, 31, East Reach, *Taunton, Somerset, England.*

CAMMANN, OSWALD, JR. (J) engineer, Davis Sewing Machine Co., *Dayton, Ohio*, (mail) 225 North Main Street.

CARR, HARRY R. (J) inspector and tester of electric trucks, Ward Motor Vehicle Co., Mount Vernon, N. Y., (mail) 209 Johnson Avenue, *Hackensack, N. J.*

CHILDS, KENNETH L. (M) research engineer, Standard Textile Products Co., New York City, (mail) The Whittier, Burns Drive, *Detroit.*

COLLINS, JOSEPH F. (M) chief engineer, Mitten-Traylor, Inc., 1108 Land Title Building, *Philadelphia.*

CONRADI, L. C. (M) chief chemist, Spicer Mfg. Corporation, South Plainfield, N. J., (mail) 143 Jackson Avenue, *Plainfield, N. J.*

COOK, ROY J. (A) Eastern manager of sales, Westinghouse Union Battery Co., Swissvale, Pa., (mail) 376 North Fullerton Avenue, *Montclair, N. J.*

CRAFT, EDWARD B. (M) chief engineer, Western Electric Co., Inc., 463 West Street, *New York City.*

CRESCENT TOOL CO. (Aff) *Jamestown, N. Y.*
Representative: Swisshelm, C. R.

DEMEILLERS, RAOUL A. (A) tool supervisor, Gould & Eberhardt, Newark, N. J., (mail) 246 Lincoln Place, *Irvington, N. J.*

DRAKE, CHARLES L. (A) sales engineer, S.K.F. Industries, Inc., 165 Broadway, *New York City.*

DRESSER, SIDNEY R. (M) cable engineer, Whitney Blake Co., 105 East 131st Street, *New York City.*

DUNNING, HUGH C. (M) assistant general manager, Olds Motor Works, *Lansing, Mich.*, (mail) 610 South Jenison Avenue.

EDGAR, F. M. (A) chief engineer, Ternstedt Mfg. Co., 6307 Fort Street, *Detroit.*

FABER, L. E. (J) mechanic, Yellow Cab Mfg. Co., 5801 West Dickens Avenue, *Chicago.*

FAIRBANK, CHARLES WILLIAM (J) test engineer, Standard Oil Co. of New Jersey, *Baltimore*, (mail) 525 East 20th Street.

FALGE, ROBERT N. (M) engineering department, National Lamp Works, Nela Park, *East Cleveland, Ohio.*

FLOYD, A. A. (J) sales engineer, Sheldon Axle & Spring Co., Wilkes-Barre, Pa., (mail) 51 West Main Street, *Miners Mills, Pa.*

FREYMAN, ALEXANDER (J) draftsman, Western Electric Co., Inc., New York City, (mail) 41 Melrose Street, *Brooklyn, N. Y.*

GESREGAN, C. WESLEY (A) sales manager, National Lead Co., 111 Broadway, *New York City.*

GREY, EDWARD (A) 1055 Virginia Avenue, *New York City.*

GRIDLEY, W. T. (A) vice-president and general manager, Depot Motor Bus Lines, Inc., 706 Sebor Street, *Chicago.*

HALLIBURTON, VIRGIL FRANCIS (E S) student, in mechanical engineering, Massachusetts Institute of Technology, *Cambridge, Mass.*, (mail) Box 204, Massachusetts Institute of Technology.

HANSEN, H. A. (M) manager, Stromberg Motor Devices Co., 2739 Woodward Avenue, *Detroit.*

KEEGIN, CURTIS W. (A) district manager, Cincinnati Ball Crank Co., Cincinnati, (mail) Room 5-107 General Motors Building, *Detroit.*

KIDDER, EDWIN H. (A) general sales manager, Dunlop Tire & Rubber Co. of America, *Buffalo.*

KIZER, KARL K. (A) chief engineer in cab department, Bauer Mfg. Co., 117 East 30th Street, *Chicago;* president, Kizer Equipment Co., 3110 South Michigan Avenue, Chicago.

LEACH, ALBERT E. (M) manager of drafting room, Studebaker Corporation of America, Piquette Avenue, *Detroit.*

LUKER, FRED (J) experimental engineer in charge of dynamometer room, A. C. Spark Plug Co., *Flint, Mich.*, (mail) 609 Mary Street.

MCKELVY, TOM M. (A) inventor and designer, McKelvy Rotary Valve Co., Inc., *Fresno, Cal.*, (mail) St. Andrews Apartments.

MCMAHON, JOHN F. (M) mechanical superintendent, Yellow Taxi Corporation, *New York City*, (mail) 640 West 153rd Street.

MAIN, FRANK L. (A) assistant sales manager and experimental engineer, Hayes Wheel Co., Jackson, Mich., (mail) 3-258 General Motors Building, *Detroit.*

MEESE, HORACE S. (M) transportation consultant, Commercial Truck Co., *Philadelphia*, (mail) 260 South 18th Street.

MELDRIM, H. W. (J) student, Carnegie Institute of Technology, *Pittsburgh, Pa.*, (mail) 420 South Dithridge Street.

MERRITT, RALPH V. (A) American Steel Chase Co., New York City, (mail) *East Williston, N. Y.*

MONJAR, J. G. (A) sales representative, Hyatt Roller Bearings Co., *Detroit*, (mail) 1381 Coplin Avenue.

NEALE, FRED (M) designer, Northway Motor & Mfg. Co., *Detroit*, (mail) 12747 Myers Road.

NELSON, REGINALD (A) chief mechanic, Borden Farm Products Co., *Brooklyn, N. Y.*, (mail) 196 Greene Avenue.

NEWMAN, ALEXANDER (E S) student, Armour Institute of Technology, *Chicago*, (mail) 343 North Central Avenue.

OESTERMEYER, CARL F. (M) electrical engineer, Willard Storage Battery Co., *Cleveland.*

OFENSEND, CHASE F. (A) mechanical engineer, Miller Rubber Co., *Akron, Ohio.*

OGAWA, YOSHIO (J) student, Tri-State College of Engineering, *Angola, Ind.*, (mail) P. O. Box 214.

PRATT, THEODORE D. (M) general manager, Motor Truck Association of America, 1819 Broadway, *New York City.*

RADFORD, W. H. (M) vice-president, Balboa Motor Corporation, *Detroit*, (mail) 1691 West Euclid Avenue.

RUSHMORE, S. W. (M) owner, Rushmore Laboratory, *Plainfield, N. J.*, (mail) 694 Belvidere Avenue.

SATTERTHWAITE, GEORGE (M) manager of steel works, Henry Disston & Sons, *Tacony, Philadelphia.*

SHIELD, JOHN (A) assistant engineer, Northern Electric Co., Ltd., *Montreal, Canada*, (mail) 79 Rozel Street.

SHIMER, WILLIAM ROBERT (M) metallurgical engineer, Bethlehem Steel Co., *Bethlehem, Pa.*

SPOFFORD, HARRY H. R. (A) mechanical engineer, Copper & Brass Research Association, 25 Broadway, *New York City.*

STARCK, W. A. (A) engineer, Badger Mfg. Corporation, 156 Clinton Street, *Milwaukee.*

STROM, GEORGE A. (A) vice-president, U. S. Ball Bearing Mfg. Co., 4535 Palmer St., *Chicago.*

SWANTESON, C. A. (A) service manager and service engineer, T. V. T. Motors Corporation, *City of Washington*, (mail) 3213 33rd Place, Northwest.

THOMSON, HORACE L. (A) research, *Leland, Mich.*

THOMSON, WILLIAM G. (A) automobile mechanic, Consumers Ice Co., *San Francisco*, (mail) 161 Chilton Avenue.

VARADY, JOHN C. (E S) student, Ohio State University, *Columbus, Ohio*, (mail) 133 Chittenden Avenue.

VOTYPKA, JOHN W. (M) body engineer, Towson Body Co., *Detroit*, (mail) 2664 Northwestern Avenue.

WALL, MAX (A) engineer, Max Wall & Co., 53 Tory Street, *Wellington, New Zealand.*

WHARAM, JOHN J. (M) assistant engineer, Lincoln Motor Co., Dearborn, Mich., (mail) 2676 Montclair Avenue, *Detroit.*

WINZENBURG, FRED C. (A) commercial artist, Winzenburg Artists, 410 South Michigan Avenue, *Chicago.*

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

INDEX TO VOLUME XIII, JULY-DECEMBER, 1923

Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

J. W. Applin has severed his connection with the Lafayette Motors Co., Indianapolis, where he was chief engineer. No announcement has been made of his future plans.

Norbert S. Atwell has been appointed instructor of ignition, starting and lighting at Vocational School No. 1 of the United States Veterans Bureau, Camp Sherman, Chillicothe, Ohio. He was formerly a partner in the firm of Atwell Auto Service Co., also located at Chillicothe.

Day H. Bacon, who was previously a designer for the Ansted Engineering Co., Connersville, Ind., has accepted a similar position with the Durant Motors, Muncie, Ind.

Arthur W. Barrow has severed his connection with the City Motor Works, Wellington, New Zealand. His plans for the future have not been announced but he is at present located in San Francisco, Cal.

A. E. Berdon is doing special development work for the Holley Carbureter Co., Detroit.

B. H. Blair, chief engineer of the Perfection Spring Co., Cleveland, until its consolidation with the Torbensen Axle and Eaton Axle companies to form the Eaton Axle and Spring Co., now holds a similar position in the spring division of the new company.

Lloyd J. Bohan has been appointed sales representative for the George D. Whitcomb Co., Rochelle, Ill.

W. H. Buderus is now automotive lubrication engineer for the Vacuum Oil Co., New York City. He was formerly assistant chief engineer doing work in connection with gas engine research for the Sun Oil Co., Toledo, Ohio.

R. H. Campbell, who was until recently technical representative for the Mercer Motors Co., Trenton, N. J., is now associated with the Erwin M. Jennings Co., Bridgeport, Conn.

G. W. Carlson, chief engineer of the Torbensen Axle Co., is now director of engineering of the axle division of the Eaton Axle & Spring Co., Cleveland, which succeeded the Torbensen company.

Reginald Clark, who was formerly superintendent for J. H. Williams & Co., Buffalo, N. Y., is now factory manager for the Western Drop Forge Co., Marion, Ind.

Russell W. Cory is now layout and design draftsman for the Master Motor Truck Co., Chicago. Prior to this he was connected with the engineering department of the Stewart-Warner Speedometer Co., also of Chicago.

Elmer S. Crocker has been made chief engineer for the Motor Transit Co., Los Angeles, Cal. He was previously chief draftsman for the Yellow Coach Mfg. Co., Chicago.

S. B. Crossman, who was formerly assistant service engineer for the Detroit Cadillac Motor Car Co., New York City, has been appointed sales engineer for the Clark Equipment Co., also of New York City.

Austin W. Day has been enrolled as a cooperative student in the Dayton Engineering Laboratories Co., Dayton, Ohio. He attended the University of Cincinnati previous to this.

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PERSONAL NOTES OF THE MEMBERS

Continued

Charles de Lukacsevics is no longer affiliated with the C. de L. Engineering Works, New York City, as chief engineer and owner. No information regarding his plans for the future is available.

A. R. Demory, president of the Timken-Detroit Axle Co., Detroit, has severed his connection with that company. His plans for the future have not been announced.

N. J. den Tex, who was formerly designing engineer for the Gallaudet Aircraft Corporation, East Greenwich, R. I., is now engineer for the Curtiss Aeroplane & Motor Corporation, Garden City, N. Y.

O. M. Donaldson, until recently manager for the Premier Service Co., New York City, has accepted a position as salesman for the Allis-Chalmers Mfg. Co., Chicago.

H. Earl is no longer associated with the Jensen Machine Co., LaGrange, Ill., but is now engineer for the Meteor Motor Car Co., Piqua, Ohio.

E. S. Echlin has opened an office as commission sales representative at Chicago. He was formerly service engineer for the J. I. Case Threshing Machine Co., Racine, Wis.

James L. Edelen has severed his connection with the Moon Motor Car Co., St. Louis, where he was engaged in automobile engineering. His plans for the future have not been announced.

E. V. Elconin, until the formation of the Eaton Axle & Spring Co., Cleveland, chief engineer of the Eaton Axle Co. of that place, now holds a similar position in the axle division of the new company.

T. H. Elleman, who was previously research engineer for the General Motors Research Corporation, Dayton, Ohio, is now associated with the experimental department of the Oakland Motor Car Co., Pontiac, Mich.

Robert C. Enos has been made vice-president and director of sales of the newly organized Eaton Axle & Spring Co., Cleveland. He was formerly vice-president and general manager of the Torbensen Axle Co., also of Cleveland, which organization is one of those that combined to form the new company.

John H. Geisse has received the appointment of aeronautical engineer for the bureau of aeronautics, Navy Department, City of Washington. Prior to this he was engineer for the Aeromarine Plane & Motor Co., Keyport, N. J.

Nahum D. Goldman has enrolled in the training school of Dodge Bros., Detroit, Mich. He formerly attended the University of Michigan, Ann Arbor.

E. Gruenewald has been appointed factory manager of the Ross Gear & Tool Co., Lafayette, Ind. He held a similar position for 16 years with the Root & VanDervoort Engineering Co., Moline, Ill.

J. C. Haggart, Jr., who has been associated with the Republic Motor Truck Co., Alma, Mich., for 9 years, has been made chief engineer, having previously been assistant chief engineer.

Gordon W. Harry has accepted a position as apprentice lubrication engineer for the Standard Oil Co., Chicago. Prior to this he attended the University of Michigan, Ann Arbor.

Charles Hollerith has become associated with the Automotive Fan & Bearing Co., Jackson, Mich., as secretary.

Major Mark L. Ireland, Quartermaster Corps, U. S. A., City of Washington, was presented with the Distinguished Service Medal recently. The ceremony took place on the campus of the University of Michigan, Ann Arbor. The medal was awarded for exceptionally meritorious and distinguished services as chief of the repair division, office of the director, Motor Transport Corps, American Expeditionary Force.

P. B. Jackson has joined the engineering department of the Pierce-Arrow Motor Car Co., Buffalo. He was formerly chief engineer for the Dittmer Gear & Mfg. Corporation, Lockport, N. Y.

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PERSONAL NOTES OF THE MEMBERS

Continued

Alexander C. Jamison has resigned as Western representative for the Sheldon Axle & Spring Co., Wilkes Barre, Pa. No announcement has been made of his plans for the future.

George W. Kerr, engineer of coach work for the Rolls-Royce of America, Inc., Springfield, Mass., has resigned. He has not made any announcement regarding his future plans.

R. G. Knight has severed his connection with the Gray-Dort Motors, Ltd., Chatham, Ont., where he was superintendent. His future plans have not been announced.

Carleton J. Lauer, who was until recently experimental engineer for the Doble Detroit Steam Motors Co., Detroit, has been appointed chief engineer of the Detroit Steam Motor Corporation, also of Detroit.

Arthur O. Lemon has been made chief engineer for the Ace Motor Corporation, Philadelphia. He was previously engineer in the motorcycle division of the Excelsior Motor Mfg. & Supply Co., Chicago.

B. A. Litchfield, who was formerly general manager of the Hess-Pontiac spring plant of the Standard Parts Co., Pontiac, Mich., has been made plant manager of the spring division of the newly organized Eaton Axle & Spring Co., Cleveland.

Alfred W. McKenna has accepted a position with the Osgood Bradley Car Co., Worcester, Mass., as master mechanic.

James S. MacGregor, who was previously associated with the Liberty Securities Corporation, New York City, is now engineer for the New York Trust Co., also of New York City.

Arthur Mayer has been appointed sales manager of the Detroit office of the Heinze Electric Co., Lowell, Mass. Prior to this he held a similar position with the Ames Products Corporation, New York City.

Thomas Midgley, Jr., has been made vice-president of the General Motors Chemical Co., Dayton, Ohio. He was previous to this the chief engineer of the fuel section of the General Motors Research Corporation, also of Dayton.

A. S. More, who was formerly president and general manager of the Denby Motor Truck Co., Detroit, has been elected president of the Selden Truck Corporation, Rochester, N. Y.

J. J. Murray has been made an assistant director with the Metro Pictures Corporation, Hollywood, Cal. Until recently he was connected with the Murray-Willat Motor & Aeroplane Corporation, Culver City, Cal., as a designer.

Jennings D. Peters has accepted a position with the Oldsmobile Co., Seattle, Wash., as shop foreman. He was previously a student at the University of Washington, which is also located at Seattle.

Alfred J. Poole has been appointed manager of the manufacturers sales department of the Robert Bosch Magneto Co., Inc., New York City.

R. C. Porter has joined the tool engineering and design department of the Studebaker Corporation of America, South Bend, Ind. He was formerly designer in the steel wheel engineering department of the Motor Wheel Corporation, Lansing, Mich.

Charles L. W. Randolph has accepted a position as mechanic for C. W. Jarvis, Courtland, Cal. Prior to this he attended Lewis Institute, Chicago.

Fred D. Rice, who was formerly sales representative for the Calorizing Co. of Pittsburgh, Pittsburgh, is now associated with the Edwin R. Knapp Co., Philadelphia, in a similar capacity.

W. W. Seabury is no longer experimental engineer for the LaFayette Motors Co., Indianapolis, but is now connected with the production department of Fordson tractor, Ford Motor Co., Detroit.

Maurice S. Shafer has become affiliated with the Nordyke & Marmon Co., Indianapolis, as head of the group control department.

E. H. Shepard, for more than 12 years associated with the Stromberg Motor Devices Co., Chicago, and for the last 5

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PERSONAL NOTES OF THE MEMBERS

Concluded

years of this time manager of its Detroit office, has been appointed general sales manager of Holley Carburetor Co., Detroit.

James H. Snyder has accepted a position as draftsman for the Pfaudler Co., Rochester, N. Y. He formerly held a similar position with the Selden Truck Corporation, also of Rochester.

W. K. Swigert has become factory manager for the Rochester Motors Corporation, Rochester, N. Y. Prior to this he was connected with the Fox Motor Car Co., Philadelphia, where he held a similar position.

Willjam O. Tait, Jr., has terminated his association with the Massachusetts Institute of Technology, Cambridge, where he was research engineer in charge of instruments in connection with tractive resistance of roads research. No announcement has been made of his future plans.

Wallace W. Tuttle who was factory manager covering engineering development and production with the Four Wheel Hydraulic Brake Co., Detroit, has severed his connection with that organization. His plans for the future have not been announced.

Charles R. Vogel has been appointed outside plant engineer for the New York Telephone Co., with headquarters at Newark, N. J. Until recently he was experimental engineer with the Oxweld Acetylene Co., which is also located at Newark.

William H. Wallace is now sales manager of the spring division of the newly organized Eaton Axle & Spring Co., Cleveland. He held a similar position with the Perfection Spring Co., before this company was taken over by the Eaton organization.

E. I. Walsh, who was formerly designer for the Baker R & L Co., Cleveland, has accepted a position with Weaver & Kemble, also of Cleveland.

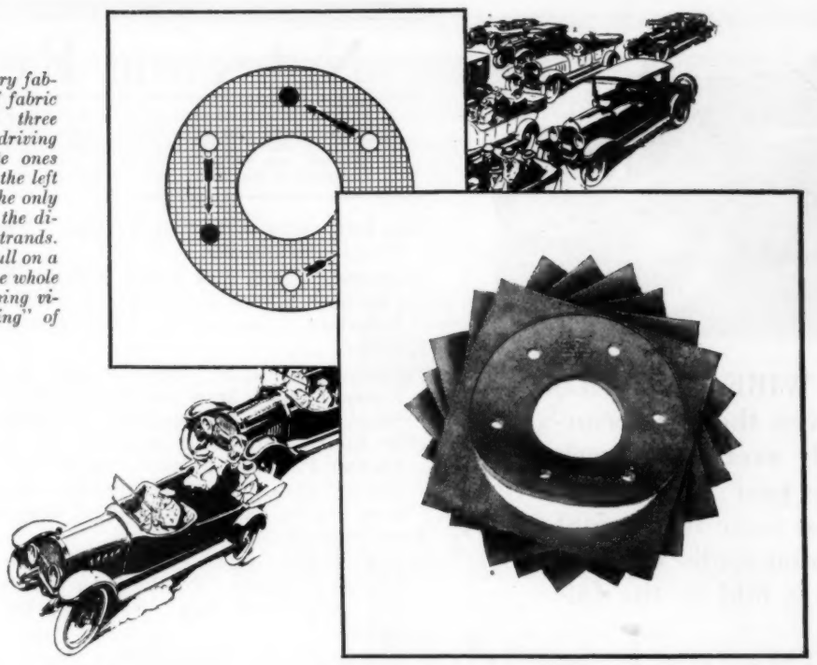
C. G. Walter has become associated with the Standard Steel Car Co., Hammond, Ind. He was until recently secretary of the Pittsburgh Model Engine Co., Pittsburgh.

W. W. Wells has resigned as chief engineer for the Clydesdale Motor Truck Co., Clyde, Ohio, and is now doing experimental engineering for the Reo Motor Car Co., Lansing, Mich.

Albert B. Werdehoff has severed his connection with the Champion Products Mfg. Co., Newark, N. J., where he was chief engineer. His plans for the future have not been announced.

William B. Wheatley has been appointed service manager of R. G. Edgerton & Co., Norfolk, Va.

At right is an ordinary fabric disc, its layers of fabric laid parallel. The three black holes are the driving bolts—the three white ones the driven. Note that the left hand driving bolt is the only one that can pull in the direction of the cotton strands. The other two must pull on a bias. This stretches the whole disc out of true, causing vibration and "whipping" of the shaft.



Now examine the Thermoid-Hardy patented Fanwise Construction. The disc is built up with the strands of each fabric layer running in a different direction. Each sector is equally strong, equally elastic. Every stress is balanced—the torsional, the centrifugal, and the lateral. This eliminates vibration and holds the shaft in true on every revolution.

The only disc universal that gives the wear without the stretch

Exclusive Fanwise Construction combines the necessary strength, wear and freedom from "whipping"

The Thermoid-Hardy patent is the base for the disc universal. Six years ago the first fabric disc—made by Thermoid-Hardy—was put on the market. Today, over 65 leading manufacturers of cars and trucks have adopted it as a standard equipment.

The thing that made this fabric disc practical is the patented Fanwise Construction.

Contrast it with an ordinary fabric disc. The Thermoid-Hardy owes its amazing strength to the fact that the strands in each layer run in *different* directions.

This gives an even stress at every point of strain—an equal "pull" between every pair of bolt holes. You find this construction *only* in the Thermoid-Hardy Universal.

Flexible, yet tremendously strong

A torsional twist of 21,000 pounds could not injure the Thermoid-Hardy disc. And the Thermoid-Hardy has given 60,000 miles on the heaviest trucks, over the roughest roads—without lubrication or adjustment.

No vibration—no jolting

Metal universals soon wear down and transmit every jolt to delicate gears and bearings. What's more, they need constant attention. The flexible Thermoid-Hardy disc delivers a smooth, even flow of power instead of jolts and lost motion.

Thermoid-Hardy discs are now packaged for distribution through jobbers and dealers for replacement sales. Full information, prices, and discounts sent on request.

A book you should have

We have prepared a book, "Universal Joints—Their Use and Misuse," that treats the subject from every angle—the mechanical principles, construction, lubrication, manufacture, strength, tests, and records of performance. Send for your copy today.

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Factory and Main Offices: Trenton, N. J.
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San Francisco London Paris Turin

LIST OF USERS
Allis Chalmers Mfg. Co.
The Autocar Co.
Available Truck Co.
Barley Motor Car Co. (Roamer)
Chandler Motor Car Co.
Crow-Elkhart Motor Corp.
Jas. Cunningham Son & Co.
Dart Truck & Tractor Corp.
The Dauch Mfg. Co.
Diamond T Motor Car Co.
Doane Motor Truck Co.
Fageol Motors Co.
H. H. Franklin Mfg. Co.
Garford Motor Truck Co.
Gramm-Bernstein Motor Truck Co.
Hawkeye Truck Co.
Hendrickson Motor Truck Co.
Highway Motors Co.
Holt Mfg. Co.
Indiana Truck Co.
International Harvester Co. of A. Inc.
International Motor Co.
Jackson Motors Corp.
Kelsey Motor Co.
Kentucky Wagon Mfg. Co., Inc.
King Zeitler Co.
Lakewood Eng. Co.
Lexington Motor Co.
Locomobile Co.
Maxwell Motors Corp.
Menominee Motor Truck Co.
Mercer Motors Co.
Moreland Motor Truck Co.
Nelson & LeMoon

LIST OF USERS
E. A. Nelson Automobile Co.
Nelson Motor Truck Co.
D. A. Newcomer Co.
O'Connell Motor Truck Co.
Oliver Tractor Co.
Oneida Motor Truck Co.
Packard Motor Car Co.
Parker Motor Truck Co.
Patriot Motors Co.
Reliance Motor Truck Co.
Reo Motor Car Co.
Reynolds Motor Truck Co.
Root & Van Dervoort Eng. Co.
Sanford Motor Truck Co.
Southwark Fdy. & Mach. Co.
Stoughton Wagon Co.
Studebaker Corp.
Stutes Mar Tractor Co.
Templar Motors Co.
Tioga Steel & Iron Co.
Towmotor Co.
Traffic Motor Truck Corp.
Transport Truck Co.
Twin City Four Wheel Drive Co., Inc.
United Motors Co.
Walter Motor Truck Co.
Ward La France Truck Corp., Inc.
Geo. D. Whitcomb Co.
Wichita Motors Co.
H. E. Wilcox Motor Co.
Willys-Overland, Inc.
Zeitler & Lamson Truck & Tractor Co.

THERMOID-HARDY UNIVERSAL JOINT

Makers of "Thermoid Hydraulic Compressed Brake Lining"
"Thermoid Crolide Compound Tires"

Notes and Reviews

In this column are given brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

THE SHROUDING OF POPPET VALVES. Published in *The Motor*, May 1, 1923, p. 509.

SCIENTIFIC TESTING OF VALVE NOISES. By Prof. A. M. Low. Published in *The Motor*, May 1, 1923, p. 542.

Describes a method by which periodic clatter is photographed.

CENTRIFUGALLY CAST PISTON-RINGS. By John A. Rathbone. NOTES ON GRAY IRON FOR AUTOMOTIVE CASTINGS. By H. B. Swan. LINEAR CONTRACTION AND SHRINKAGE OF A SERIES OF LIGHT ALUMINUM ALLOYS. By Robert J. Anderson. RECENT PROGRESS IN THE APPLICATION OF THE ALUMINUM ALLOY "ALPAX" IN THE FOUNDRY. By R. de Fleury.

Four papers read at the annual meeting of the American Foundrymen's Association.

MOTOR FUELS: THEIR PRODUCTION AND TECHNOLOGY. By Eugene H. Leslie. Published by the Chemical Catalog Co., Inc., New York City. 681 pp.; 166 illustrations; 120 tables.

Professor Leslie's book, which deals principally with the production of motor fuels, should be useful as a reference book, not only on account of the presentation of scientific fundamentals, but also because of the review of research work in several fields in which much work remains to be done. Its value as a reference work is greatly enhanced by well-selected tabular information, lists of references and diagrams, although the author has avoided giving such information as is readily available in standard engineering and physical and chemical handbooks.

AUTOMOBILE GASOLINE: ITS DANGERS AND TESTS. By Augustus H. Gill. Published by the J. B. Lippincott Co., Philadelphia. 54 pp.; 6 illustrations; 5 tables.

Users of gasoline, chemists, engineers or laymen will be interested in this compact handbook on the properties, peculiarities and dangers of gasoline. Much information that has appeared in the Bureau of Mines publications is presented in a handy and readable form as, for instance, various methods of testing and analyzing gasoline.

DECAYS AND DISCOLORATIONS IN AIRPLANE WOODS. By J. S. Boyce. United States Department of Agriculture Bulletin No. 1128. Published by the Government Printing Office, City of Washington. 51 pp.; 9 illustrations; 7 colored plates.

The purpose of this bulletin is to enumerate and describe the more important decays and discolorations to which woods used in aircraft construction are subject, and the conditions under which they occur. It is well known that the initial and incipient stages of decay; that is, the first steps in weakening wood, are indicated by discolorations, but wood is subject to many color variations from the normal not caused by wood-destroying fungi. In the airplane industry, where the very finest quality of high-grade wood is demanded, and in which there is a maximum of unavoidable waste in the remanufacture of the lumber, it is imperative that no suitable material be wasted, while at the same time it is equally important that all weakened material be excluded.

THE ENDURANCE OF BALL BEARINGS WITH PARTICULAR REFERENCE TO AUTOMOBILE PRACTICE. By A. W. Macaulay. Paper read before the Institution of Automobile Engineers, London, May, 1923. 46 pp.; 20 illustrations. Discussion in *The Motor*, May 22, 1923, p. 661.

At the present time there is considerable controversy between designers regarding developments in the manufacture and application of ball bearings. Many of the points in question were raised by Mr. Macaulay and many more came up in the course of the discussion that followed the author's presentation.

(*Continued on p.* 12)

NOTES AND REVIEWS

Continued

The method adopted in the paper is to state the views of the supplier of ball bearings on the endurance question in terms of factors of safety over published "rated capacities," following this up by an analysis of a specific car and a graphical representation of the same facts for a number of cars, so as to bring out representative practice, and finally to connect these up, showing where economies can be effected, and a more rational bearing selection made possible. The treatment is confined to passenger-car work.

NATIONAL RESEARCH COUNCIL PUBLICATIONS.

Bulletin No. 3. List of Periodical Bibliographies and Abstracts of the Scientific and Technological Journals of the World.

Bulletin No. 16. Research Laboratories in Industrial Laboratories in the United States, including Consulting Research Laboratories.

One of the most useful activities of the research information service of the National Research Council in the City of Washington is the compilation and issuance in convenient form of significant facts about scientific research and its industrial relations. Often the facts assembled to meet the immediate needs of an individual engineer-investigator, firm or association, are of sufficient interest and value to justify publishing. Informational reports thus prepared are available either at cost or free.

OILINESS OF LUBRICATING OILS AND VISCOSITY OF LUBRICATING OILS AT HIGH PRESSURES. First and third reports of the Special Committee on Lubrication of the American Society of Mechanical Engineers, 29 West 39th Street, New York City; 8 pp.; 2 tables.

This special committee of the American Society of Mechanical Engineers has recognized certain problems as definitely awaiting solution; among them being those relating to the behavior of lubricants at high pressures and temperatures. The conditions existing in bearings operating under moderate pressures, with therefore relatively thick oil-films, are fairly subject to analytical treatment based on the assumption that the viscosity of the lubricant is the sole factor affecting its operation. On the other hand under conditions of very high pressures or high temperatures, or both, it is a common experience that certain organic oils are much more effective in reducing friction than are mineral oils of similar viscosity, as ordinarily measured. The property or properties causing such differences in lubricating value are as yet more or less obscure and thus far no conclusive experimental evidence has been obtained to show the nature of the physical processes accounting for the observed differences in the lubricating value. In discussing this problem, the committee has drawn up a series of recommendations concerning the lines along which investigation might be conducted.

JET PROPULSION FOR AIRPLANES. By Edgar Buckingham. National Advisory Committee for Aeronautics. Report No. 159. Published by the National Advisory Committee for Aeronautics, City of Washington. 18 pp.; 11 tables; 2 illustrations.

This report is a description of a method of propelling airplanes by the reaction of jet propulsion. Air is compressed and mixed with fuel in a combustion-chamber where the mixture burns at a constant pressure. The combustion products issue through a nozzle, and the reaction of the jet constitutes the thrust. Data are available for an approximate comparison of the performance of such a device with that of the engine-driven airplane propeller. The computations are outlined and the results given by tables and curves.

Propulsion by the reaction of a simple jet cannot compete in any respect with that by an airplane propeller at such flying speeds as are now in prospect, since at 250 m.p.h. the jet would take about four times as much fuel per thrust horsepower-hour as a propeller and the powerplant would be much heavier and more complicated.

(*Concluded on p.* 14)

NOTES AND REVIEWS

Concluded

SOME BOOKS ON PAINTS AND VARNISHES AND WOOD FINISHING. Forest Products Laboratory. Technical Note No. 195. Published by the United States Forest Service, Madison, Wis. 5 pp.

This is an excellent list of references covering the general subject indicated in the title, as well as oils, pigments, resins and varnishes and paint-testing, analysis and specifications. It should prove valuable to anyone who is making a serious study of body building and finishing.

THE USE OF SPECIAL STEELS IN AUTOMOBILE CONSTRUCTION. By J. Hebert. Published in *La Technique Moderne*, May 1, 1923, p. 273, and May 15, 1923, p. 293.

The author, in two ably-written articles, examines the properties and relative advantages, particularly from the point of view of elasticity and resilience, and recommends the use of certain special steels for specified automobile parts. These two articles constitute a useful contribution to metallography.

THE INDUSTRIAL APPLICATION OF CATALYSIS IN ORGANIC CHEMISTRY. By A. Mailhe. Published in *La Technique Moderne*, May 1 1923, p. 257.

This article, which is accompanied by a comprehensive list of references, is a valuable addition to the literature that has appeared in the 20 years that have elapsed since catalysis was first shown to afford a practical solution of many problems in organic chemistry. In this paper the author examines various experiments based upon the use of catalytic methods, using the following catalytic agents: Metals, metallic oxides, metallic salts and acids. The author states in his conclusions that German chemists have played a leading part in this chemical development and have developed much new apparatus, devoting most of their attention to hydrogenation problems.

INTERNAL COMBUSTION ENGINE CAMS. By B. B. Low. Published in *Engineering*, May 25, 1923 p. 641. 12 illustrations.

This paper gives a mathematical analysis of the cams most generally used in internal-combustion engines and also considers definite examples showing the relative merits as regards average lift, spring strength, noise, etc., of the different types. Owing to the inherent inaccuracies of graphical methods the mathematical analysis is to be preferred; also it is undoubtedly quicker to substitute numerical values in a formula than to undertake a comparatively long graphical construction.

Four types of cam are discussed: concave, straight and convex cams with roller followers and a convex cam with a flat-footed follower.

SOLDERS FOR ALUMINUM. Second Edition. Bureau of Standards Circular No. 78. Published by the Government Printing Office, City of Washington.

EXPERIMENTS WITH A BUILT-IN OR FUSELAGE RADIATOR. By C. Wieselsberger. National Advisory Committee for Aeronautics, Technical Note No. 141. Published by the National Advisory Committee for Aeronautics, City of Washington.

1923 REPORT OF THE ELECTRIC TRUCK AND CAR BUREAU OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION. Presented at the annual convention of the association in New York City, June 4, 1923.

SHELLAC. By P. H. Walker and L. L. Steele. Bureau of Standards Technologic Paper No. 232. Published by the Government Printing Office, City of Washington.

DEFECTS IN AUTOMOBILE STEEL SHEETS. By George F. Comstock. Published in *The Iron Age* May 24, 1923, p. 1475. Numerous photographic illustrations.

In this article the causes are explained by a metallographic examination of 20 samples.


KERITE
A product of over fifty years distinguished service in the most important electrical fields, possessing inherent characteristics which make it pre-eminently desirable for
High Tension Automotive Ignition
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Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

George H. Abel has become associated with L. V. Estes, Inc., Chicago, as consulting industrial engineer.

Vayne M. Armstrong has been made secretary and sales manager of E. W. Showalter & Co., Indianapolis. He was previously assistant manager of the Edie Battery Co., also of Indianapolis.

Tomas T. Atangan, who was formerly connected with the engine testing department of the tractor works of the International Harvester Co., Chicago, has gone to the Philippine Islands, where he will take a position as mechanical engineer.

M. H. Blank has been appointed works manager of Elgin Motors, Inc., Indianapolis, which was recently organized. He will have supervision over the designing and the production of the new model Elgin car. He was previously assistant general manager in charge of engineering and production for the Cole Motor Car Co., also of Indianapolis.

Louis W. Blauman has returned to the Light Mfg. & Foundry Co., Pottstown, Pa., as sales representative. He was until recently sales manager for the C. M. Grey Mfg. Co., East Orange, N. J.

George E. Burger, Jr., of Snead & Co. Iron Works, Jersey City, N. J., has been made assistant production engineer, having formerly been estimating engineer.

René L. Cros sailed for France on July 14 and after a 3 months' vacation will enter the Ecole Superieure d'Aeronautique in Paris. He has been doing final inspection work for the Delco Light Co., Dayton, Ohio.

W. S. Crowell has resigned as dean of the San Francisco Y. M. C. A. Automotive School, and is now service salesman for the Chester N. Weaver Co., also of San Francisco.

George Q. Downes, Jr., has accepted a position as an assistant engineer for the Philadelphia Quartz Co., Philadelphia. Until recently he attended the Ohio State University, Columbus.

Earl E. Eby has returned to the Hyatt Roller Bearing Co., Newark, N. J., as assistant to the general sales manager. He was previously service manager for the Remy Electric Co., Anderson, Ind.

R. J. Fitness has resigned as chief engineer and factory manager of the Handley Motors Corporation, Kalamazoo, Mich., and is now associated with the central planning division of the Maxwell Motor Corporation, Detroit.

L. J. Fralick has joined the sales department of the Parish & Bingham Corporation, Cleveland. He recently resigned as assistant sales manager for the Hydraulic Pressed Steel Co., also of Cleveland.

(*Continued on p. 4*)

PERSONAL NOTES OF THE MEMBERS

Continued

T. B. Funk, who was formerly president of the T. B. Funk Co., Indianapolis, is now affiliated with the Automotive Fan & Bearing Co., Jackson, Mich.

A. D. Gardner has been appointed director of the home study department of the Michigan State Automobile School, Detroit.

C. E. Gary, who until recently was designer for the Elwell Parker Electric Co., Cleveland, has become checker and designer for the Chandler Motor Car Co., also of Cleveland.

George H. Grundy has been appointed manager of steel sales for Peter A. Frasse & Co., Inc., New York City.

N. F. C. Haberkost has accepted a position as draftsman for the Vaughn Machinery & Engineering Co., Cuyahoga Falls, Ohio. He has been taking the mechanical engineering course at the Ohio State University, Columbus.

Dr. D. R. Harper 3rd, physicist, Bureau of Standards, has been transferred from the City of Washington to New York City to serve as liaison officer between the Bureau of Standards, the Federal Specifications Board and the American Engineering Standards Committee with headquarters in the offices of the last named in the Engineering Societies Building, 29 West 39th Street, New York City.

George Heinish has accepted a position as mechanical draftsman in the truck equipment department of the Van Dorn Iron Works, Cleveland. He was formerly engaged in a similar capacity on tractors, tanks and automobile gun mounts for the Ordnance Department at the Rock Island Arsenal, Rock Island, Ill.

S. J. Hunt, who was previously manager and lubrication engineer of J. D. Streett & Co., Inc., St. Louis, has become affiliated with the Galena-Signal Oil Co. of Texas, Houston.

J. B. Lindecker has accepted a position as layout draftsman in the patent drafting department of the Willys-Overland Co., Toledo. His former business connection was with the Pinkerton Tobacco Co., also of Toledo, as experimental and efficiency engineer.

G. J. Lux has resigned as chief engineer of the Detroit Gear & Machine Co., Detroit. No announcement has been made of his future plans.

H. N. Marsh, who was formerly assistant in engineering at the California Institute of Technology, Pasadena, and also associated with the San Diego & Arizona Railway, has joined the testing department of the General Petroleum Co., Los Angeles.

Wilbur A. Martin has severed his connection with the Glenn L. Martin Co., Cleveland, where he was designer in charge of layout, and has become associated with the aeronautical division of the Goodyear Tire & Rubber Co., Akron.

H. L. Montanya has been made chief inspector and quality engineer for the Teagle Magneto Co., Cleveland. He was previously chief inspector for the Yard-O-Meter Corporation. St. Louis.

Arthur F. Ochtman of the Buda Co. has been transferred from Harvey, Ill., where he was field manager, to the New York City office, and is engaged in sales and engineering work in the power unit department of that company.

Dent Parrett, who was formerly president and general manager of the Hicks-Parrett Tractor Co., Chicago Heights, Ill., has become affiliated with the Washburne Co., Chicago.

(*Concluded on p.* 6)

PERSONAL NOTES OF THE MEMBERS

Concluded

Nelson C. Peck is an apprentice leading to a metallurgical position with the Metropolitan Engineering Co., Brooklyn, N. Y. He was until recently a student in mechanical engineering at the Sheffield Scientific School, Yale University, New Haven, Conn.

Edward D. Perry, who was previously research engineer for the Elliott-Fisher Co., Harrisburg, Pa., has accepted a position as mechanical engineer with the Scintilla Magneto Co., Inc., New York City.

Carl H. Peterson is now associated with the Standard Stoker Co., New York City. He was until recently secretary, treasurer and general manager of the Maher Engineering Co., Chicago.

Finley R. Porter has severed his connection with the Humphreys Oil Co., Mexia, Tex. His plans for the future have not been announced.

Frank J. Resel of the American Gear Co., Jackson, Mich., has been made manager of the Chicago branch. He was formerly sales engineer in Chicago.

Paul F. Shivers has accepted a position with the Honeywell Heating Specialties Co., Wabash, Ind. Prior to this he was electrical engineer for the Webster Electric Co., Racine, Wis.

E. F. Smeckel has severed his connection with the Walker Axle Co., Chicago, where he was assistant chief engineer. No information regarding his plans for the future is available.

J. W. Stack, who was previously chief lubrication engineer for the Standard Oil Co. of Indiana, Chicago, has been appointed sales manager for the Badeker Mfg. Co., also of Chicago.

Hubbard W. Steiner has been made general manager of the Dearborn Truck Co., Chicago. He formerly held a similar position at the Cincinnati axle plant of the Standard Parts Co., Carthage, Ohio.

W. C. Stettinius, who for the past 18 months has been serving in the capacity of sales manager of the equipment division, has been made first vice-president and general manager of the American Hammered Piston Ring Co., Baltimore, Md.

D. R. Veazey has accepted a position as designer for the Yellow Coach Mfg. Co., Inc., Chicago. He previously held a similar position with the Duesenberg Automobile & Motor Co., Indianapolis.

Gustav Wade, who was until recently an aeronautical mechanical engineer in the engineering division of the Air Service, McCook Field, Dayton, Ohio, is now associated with the Bureau of Mines and is located at San Francisco.

Earl Alger Wales has been appointed special representative of the Corporation for Inventory Conversion, Springfield, Mass. He was formerly general manager of the Peters Machine & Mfg. Co., Cleveland.

B. W. Wallace is a cadet in the training course of the Toledo Edison Co., Toledo. He received his technical education in the school of mechanical engineering, Purdue University, West Lafayette, Ind.

Ernest A. Weiss is connected with the engineering department of the Yellow Coach Mfg. Co., Chicago, and not the Yellow Cab Mfg. Co., as mentioned in the June issue of THE JOURNAL.

L. A. Zeigler has severed his connection with the Zeigler Mfg. Co., Alexandria, Ind., where he was general manager. His plans for the future have not been announced.

Notes and Reviews

In this column are given brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

MOTOR TRANSPORTATION OF MERCHANDISE AND PASSENGERS. By Percival White. Published by McGraw-Hill Book Co., New York City. 477 pp.; 76 illustrations; 24 tables.

The author of this book has undertaken the treatment of motor transportation in all its important phases and applications; the vehicle, the road and the operation of vehicles over the road are presented as the principal closely-related factors involved in the general problem. Many practical matters involving the organization and the operation of transportation systems, as well as the technical aspects of the design, the construction and the maintenance of both the vehicle and the highway, are discussed. One chapter is devoted to cost accounting and another to insurance. Truck legislation is also treated in some detail. A short bibliography covering the subject from 1916 to 1922, inclusive, is to be found at the end.

THE PROBLEMS OF THE ENGINE INDICATOR. By Loughnan Pendred. A NEW FORM OF OPTICAL INDICATOR. By Prof. F. W. Burstall. MICRO-INDICATOR FOR HIGH-SPEED ENGINES. By W. G. Collins. R. A. E. ELECTRICAL INDICATOR FOR HIGH-SPEED INTERNAL-COMBUSTION ENGINES AND GAGE FOR MAXIMUM PRESSURES. By Harry Wood.

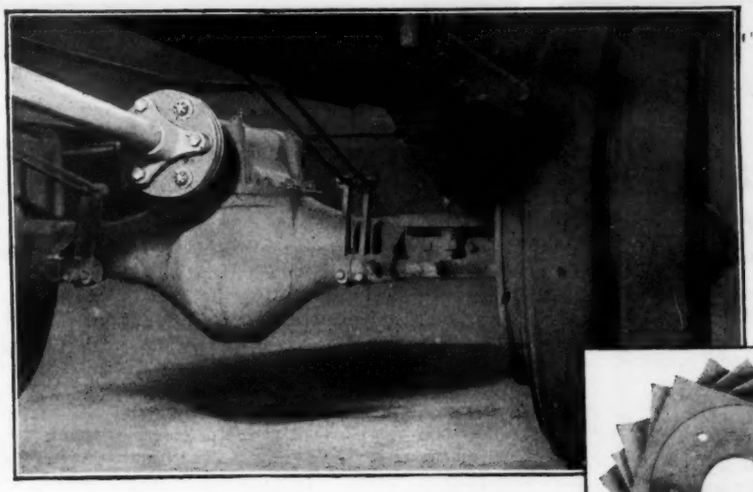
A series of four papers forming a symposium on the subject of Indicators that was presented at a meeting of the Institution of Mechanical Engineers. Published in the *Proceedings of the Institution of Mechanical Engineers*, No. 2, 1923, p. 95.

The author of the first paper treats briefly the problems of inertia and spring vibration in engine indicators; he discusses the drum and its mechanism as well as the springs and pistons. A description of the numerous types of optical indicator is given, and in conclusion the author presents in tabular form structural details and other information relating to engine indicators in the Science Museum at South Kensington, England. This article offers a good review of the stages in the development of engine indicators.

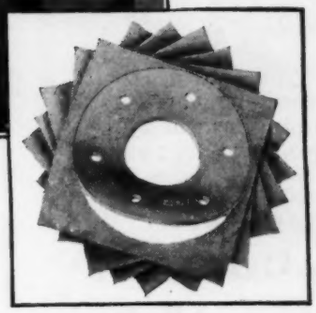
The second paper describes in detail an optical indicator of the piston type developed at the University of Birmingham for research work on medium-speed high-compression gas engines and for general laboratory use. The instrument including the camera recorder is constructed almost entirely of metal. It is designed for speeds up to 2000 r.p.m. and for a pressure of 600 lb. per sq. in. Particular attention has been paid to details of lubrication and cooling. Several features in the construction of this indicator will be of interest to designers and users of such instruments. Sample cards for various loads and speeds are given at the conclusion of the paper.

The Collins micro-indicator discussed in the third paper is of the cylinder and piston type. The principal novel feature is the production on transparent celluloid of small-scale diagrams that may be examined and evaluated by the use of a suitable microscope fitted with a graticule. In making records of this type advantage is taken of the susceptibility of the celluloid to slight plastic deformation when acted upon by a properly formed recording stylus. The diagrams thus produced, when suitably enlarged, can be evaluated to a high order of accuracy. Enlarged records can also be obtained by simple photographic methods. An automatic switch of ingenious design is used to control the recording stylus so that it remains in contact with the recording surface for one complete engine-cycle only. The instrument can be controlled from a distance and is thus adapted to road tests. The paper contains a discussion of the errors of the instrument and the manner in which many difficulties have been surmounted. Diagrams and illustrations are included to supplement the text.

(*Continued on p.* 10)



In building up the flexible fabric discs, the several layers of fabric are put together so that the strands in each piece run in a different direction. This patented Fanwise Construction provides the greatest tensile strength.



Delivers the power without the jolts

Why rugged strength, long wear, and freedom from vibration are found only in the universal of Fanwise Construction

Metal universals are being displaced because they transmit every shock of the road to the driveshaft.

Ordinary fabric disc universals pull out of shape after a few thousand miles, causing vibration and "whipping." Their unscientific construction is responsible for this.

Fanwise Construction gives maximum flexibility and strength

Now look at the diagram above. Notice how the layers of fabric are built up, the strands of cotton in each layer running in a different direction. Each sector is equally strong and elastic. Every stress is equally balanced. That's why the Thermoid-Hardy disc *cannot* stretch out of shape.

The patented Fanwise Construction gives strength to withstand a 21,000 pound twist; endurance to go 60,000 miles on the heaviest trucks without attention; and a flexibility which cushions and protects the delicate gears and bearings!

Fanwise Construction has made the fabric disc practical. It was perfected only five years ago—yet today there are over 3,000,000 in daily use. And 66 leading manufacturers of cars and trucks have adopted the Thermoid-Hardy universal as standard equipment.

Thermoid-Hardy discs are now packaged for distribution through jobbers and dealers for replacement sales. Full information, prices, and discounts sent on request.

A book you should have

We have prepared a book, "Universal Joints—Their Use and Misuse," that treats the subject from every angle—the mechanical principles, construction, lubrication, manufacture, strength, tests, and records of performance. Send for your copy today.

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LIST OF USERS

Allis Chalmers Mfg. Co.
The Autocar Co.
Available Truck Co.
Barley Motor Car Co. (Roamer)
Chandler Motor Car Co.
Crow-Elkhart Motor Corp.
Jas. Cunningham Son & Co.
Dart Truck & Tractor Corp.
The Dauch Mfg. Co.
Diamond T Motor Car Co.
Doane Motor Truck Co.
Fageol Motors Co.
H. H. Franklin Mfg. Co.
Garford Motor Truck Co.
Gramm-Bernstein Motor Truck Co.
Hawkeye Truck Co.
Hendrickson Motor Truck Co.
Highway Motors Co.
Holt Mfg. Co.
Indiana Truck Co.
International Harvester Co. of A. Inc.
International Motor Co.
Jackson Motors Corp.
Kelsey Motor Co.
Kentucky Wagon Mfg. Co., Inc.
King Zeitler Co.
Lakewood Eng. Co.
Lexington Motor Co.
Locomobile Co.
Maxwell Motors Corporation
Menominee Motor Truck Co.
Mercer Motors Co.
Moreland Motor Truck Co.
Nelson & LeMoon
E. A. Nelson Automobile Co.
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D. A. Newcomer Co.
O'Connell Motor Truck Co.
Oliver Tractor Co.
Oneida Motor Truck Co.
Packard Motor Car Co.
Parker Motor Truck Co.
Patriot Motors Co.
Reliance Motor Truck Co.
Reo Motor Car Co.
Reynolds Motor Truck Co.
Root & Van Dervoort Eng. Co.
Sanford Motor Truck Co.
Southwark Fdy. & Mach. Co.
Stoughton Wagon Co.
Studebaker Corp.
Stutes Mar Tractor Co.
Templar Motors Co.
Tioga Steel & Iron Co.
Towmotor Co.
Traffic Motor Truck Corp.
Transport Truck Co.
Twin City Four Wheel Drive Co., Inc.
United Motors Co.
Walter Motor Truck Co.
Ward La France Truck Corp., Inc.
Geo. D. Whitcomb Co.
Wichita Motors Co.
H. E. Wilcox Motor Co.
Willys-Overland, Inc.
Zeitler & Lamson Truck & Tractor Co.

NOTES AND REVIEWS

Continued

The R. A. E. indicator that forms the subject of the last paper is of the "balanced" type in which the varying cylinder-pressures are not recorded directly, but the time is noted at which the pressure in the cylinder just balances some standard pressure. These pressures are varied step by step, and the times for balancing are recorded. Thus a set of time records covering the whole range of engine pressures is obtained, although each pair of records belongs to a different engine-cycle. With the R. A. E. indicator a complete pressure-record on a time basis can be obtained in 10 sec. The "balance" point is obtained when the engine pressure just lifts a small valve loaded with a known air-pressure. This motion of the valve breaks an electric circuit which in turn causes an electric spark to perforate the record sheet held on a rotating drum running at half the engine speed. The sparking point, which moves at a relatively slow rate from one end of the recording drum to the other, is attached to a piston in the indicator cylinder which is driven forward by air pressure against the resistance of springs. The balancing pressure on the above-mentioned valve is the same as that in the indicating cylinder, since they are both connected to the same supply. It will be understood, therefore, that the instant at which sparking occurs will always coincide with a definite position of the sparking point; and, since the rotations of the drum correspond with those of the engine, the sparking will take place at fixed positions on the drum. The paper is illustrated with diagrams, and a table of actual measurements on various engines is included.

The discussions of all four papers bring out a wealth of very interesting information and comment. Persons interested in this subject should examine the material carefully.

BRITISH STANDARD SPECIFICATIONS FOR MOTOR AND AVIATION SPIRIT. Published by British Engineering Standards Association, London.

Contains specifications for (*a*) motor spirit, (*b*) aviation spirit 720 and (*c*) aviation spirit 760. The three appendices to these specifications apply to methods for determination and to the non-applicability of certain clauses when motor spirit consists mainly of benzol or toluol.

THE EFFECT OF SPEED ON MIXTURE REQUIREMENTS. By Claude S. Kegerreis and Gilbert A. Young, Purdue University Engineering Experiment Station. Bulletin No. 11. Published by Purdue University, Lafayette, Ind. 32 pp.; 16 illustrations.

This bulletin describes tests conducted by the authors at the Purdue University Engineering Experiment Station to establish the mixture-ratios required by an automobile engine, as affected more especially by speed.

Following is the summary of results as presented:

(1) At any given engine-load, a constant mixture-ratio is required at all speeds for maximum power and maximum efficiency at that load

(2) Idling loads at all speeds necessitate richer mixture-ratios for both power and efficiency than the higher loads

(3) The mixture requirements are not appreciably affected by the kind of automobile engine if the temperature for carburetion is adequate and the distribution is uniform in each and the compression-ratio is the same

(4) A definite relationship between the engine load and the mixture-ratios required for maximum efficiency exists

(5) Dry mixtures are not absolutely necessary for good performance, but a dry mixture will allow leaner fuel-air ratios than can be utilized when operating with wet or heavy fog conditions

(6) The ideal carbureter must recognize more than air flow, or engine load

(*Continued on p.* 12)

NOTES AND REVIEWS

Continued

(7) Mixtures must be enriched for acceleration when changing to a different speed or load for economical operation

(8) Operation under throttled conditions, except very low loads, allows lean ratios to be utilized, thus maintaining high economy

(9) When full-load operation requires maximum power to be delivered, the mixture-strength must be enriched

PUBLICATIONS OF THE BUREAU OF STANDARDS. Bureau of Standards Circular No. 24. Published by the Government Printing Office, City of Washington.

The present, or sixth, edition contains a list and short descriptions of 429 scientific papers, over 200 technologic papers, 119 circulars, 4 handbooks and 49 miscellaneous publications. A supplement covering subsequent publications up to Jan. 31, 1923, is included. This contains also a list of Government Depository Reference Libraries.

FUEL REQUIREMENTS OF INTERNAL-COMBUSTION ENGINES. By Stanwood W. Sparrow. Published in *Industrial and Engineering Chemistry*, May, 1923, p. 476.

In his treatment of fuel requirements, Mr. Sparrow considers the problem from the standpoint of (*a*) availability, (*b*) usability and (*c*) power-producing ability. It is pointed out that a fuel to be of value for use in automobile and other internal-combustion engines must be readily obtainable as a reasonably uniform product throughout a considerable territory. Some foreign powers have drawn up specifications requiring fuels such that motor vehicles using them in time of peace can also operate with fuels available in time of war without the necessity of important changes in the engine.

The term "usability" is considered as involving several factors: (*a*) the factor of portability which concerns the safe carrying of adequate supplies of fuel; (*b*) the ease of preparation of the fuel for combustion; (*c*) the distribution of the fuel to the cylinders; and (*d*) burning the fuel in the time available. Other factors discussed in connection with usability are the explosive and the distillation ranges; the latent heat of evaporation; the flash, freezing and separation points, the viscosity, the detonation characteristics, the spontaneous-ignition temperature and corrosiveness.

The paper is concluded by a brief review of the items involved in the power-producing ability of a fuel. In this conclusion is brought out the difference between the calorific value per unit weight, per unit volume and per unit volume of combustible mixture.

INTERNATIONAL ROADS CONGRESS IN SEVILLE. *Engineering*, May 11 and May 18, 1923, pp. 591 and 626.

GASEOUS COMBUSTION AT HIGH PRESSURES. An address delivered before the Royal Institution of London. Summarized in *Engineering*, May 18, 1923, p. 625.

TEN YEARS' TESTING OF MODEL SEAPLANES. By G. S. Baker. Published in the *Journal of the Royal Aeronautical Society*, May, 1923, p. 224.

METHODS OF MAKING BABBITTED BEARINGS. By Fred H. Colvin. Published in *American Machinist*, May 17, 1923, p. 735.

AN INVESTIGATION OF THE FATIGUE OF METALS. By H. F. Moore and T. M. Jasper. University of Illinois Bulletin No. 136. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill.

FACTORS GOVERNING THE STRENGTH OF GEAR-TEETH. By Douglas T. Hamilton. Published in *American Machinist*, May 31, 1923, p. 787.

ABRASION TESTING. Published in *India Rubber World*, June, 1923, p. 566.

Describes a machine for determining the relative resistance to abrasion of tire treads.

(*Concluded on p.* 14)

NOTES AND REVIEWS

Concluded

CUTTING WORM-GEARS. By Franklin D. Jones. Published in *Machinery*, June, 1923, p. 785.

SUPER-CHARGING. Published in *Autocar*, May 4, 1923, p. 757.

Outlines the development of the super-charger as a means of increasing the efficiency of a given size of engine.

LATHE BREAKDOWN TESTS OF SOME MODERN HIGH-SPEED TOOL STEELS. By H. J. French and J. Strauss. Bureau of Standards Technologic Paper No. 228. Published by the Government Printing Office, City of Washington.

RELATION BETWEEN AERONAUTICAL RESEARCH AND AIRCRAFT DESIGN. By Joseph S. Ames. Wilbur Wright Lecture given before the Royal Aeronautical Society, London, May 31, 1923.

THE DETECTION OF SULPHUR IN NATURAL-GAS GASOLINE AND THE TREATMENT FOR THE REMOVAL OF CERTAIN SULPHUR COMPOUNDS. Bureau of Mines Serial No. 2462. Published by the Government Printing Office, City of Washington.

THE MODERN INDUSTRIAL GEAR. By W. H. Phillips and L. F. Burnham. Published in *Proceedings of the Engineers' Society of Western Pennsylvania*, February, 1923, p. 19. 10 illustrations.

A resume of the most recent developments in gear design and manufacture.

GEAR GRINDING. Published in *The Automobile Engineer*, June, 1923, p. 170. 3 illustrations.

A description of the construction and operating details of the Lees-Bradner machine. This gear grinding machine uses a large flat-sided wheel inclined at an angle to the vertical, that is equal to the pressure angle of the gear to be ground.

A new form of gear-testing device for users of ground gears is described at the end of this article. This equipment provides a means for checking tooth spacing and tooth profile.

REAR-AXLE WORM-SHAFTS. By D. Cecil M'Intosh. Published in *The Automobile Engineer*, June, 1923, p. 172.

This article contains an analysis of the deformations taking place in a worm-shaft under load. A method is presented for computing shafts of suitable dimensions to withstand given loads without excessive deformation.

SLEEVE-VALVE ENGINES. By E. B. Wood. Published in *The Automobile Engineer*, June, 1923, p. 183.

Reviews the details of various types of sleeve-valve engine.

UNE ANALYSE DES TENSIONS ET FLEXIONS DANS LES RESSORTS A LAMES. By D. Landau. Published in *La Technique Automobile et Aerienne*, No. 121, p. 33.

An interesting mathematical analysis covering the tension and bending of leaf springs. The results of various tests on such springs are reported.

LE SYSTEME MOTEUR-AVION: L'ACCOUPLEMENT DIFFERENTIEL. By A. Le Bidolec. Published in *La Technique Automobile et Aerienne*, No. 121, p. 45.

This article first discusses the tendencies toward the reduction of weight and the increase in power and safety in the design of airplane engines. The advantages of grouping a number of engines in a central powerplant to drive one or more propellers are mentioned, and the difficulties thus far experienced in the realization of a satisfactory installation are brought out. A detailed treatment of the proposed method of coupling by a differential gearing system and a study of typical cases of such coupling are undertaken in conclusion.

THE MANUFACTURE AND INSPECTION OF LEAF SPRINGS. By H. G. Peebles. Published in *Transactions of American Society for Steel Treating*, June, 1923, p. 907. 20 illustrations.

Describes a trip through the factory and the warehouse of one of the largest leaf spring manufacturers. A discussion of the microstructure of metals is given, and the paper closes with a review of the manufacturing methods.

Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

C. K. Alexander, who for the past 12 years has been connected with the Wheeler-Schebler Carbureter Co., Indianapolis, has been transferred from the main office, where he was a salesman, to the new Cleveland office. Mr. Alexander will have charge of this office and will handle the sales engineering work in this territory.

Harry G. Baldwin is no longer factory manager for the Standard Steel & Bearings, Inc., Plainville, Conn., but has become associated with the New Departure Mfg. Co., Bristol, Conn.

Percy H. Bartlett has been appointed sales engineer for the Standard Spring Co. and the Trainor National Spring Co., with offices in Chicago. He was formerly superintendent in charge of motor vehicles for the Edward Lasham Co., also of Chicago.

Oscar L. Bock, who was previously associated with the service department of the LeRoi Co., Milwaukee, has accepted a position as salesman for the Bailey Motor Car Co., also of Milwaukee.

Fred W. Cederleaf has been appointed consulting engineer for the A. C. Spark Plug Co., Flint, Mich. Prior to this he was factory manager for the Metal Specialty Co., Cincinnati, Ohio.

W. G. Clark, who for the past year has been in charge of the lubricating engineering department of the Northwestern division of the Pure Oil Co., at Minneapolis, has been transferred to the main office of the company at Columbus, Ohio, and will perform similar duties, having the entire United States as his territory.

Harvey E. Clay, who until recently was assistant general manager for the Detroit Gear & Machine Co., Detroit, has been elected secretary of the Wolverine Bumper & Specialty Co., Grand Rapids, Mich.

John Coapman, for the past 3½ years, manager of the Russel Motor Axle Co., Detroit, directing sales and engineering, has severed his connection with that company. No announcement has been made of his future plans.

Norman Craig is no longer president of the Light Alloys Co., Cleveland, but has become affiliated with Frank Seaman, Inc., New York City.

Ira S. Crissman, who was formerly wheel engineer for the Disteel Wheel Corporation, Detroit, is now engineer for the Motor Wheel Corporation, Lansing, Mich.

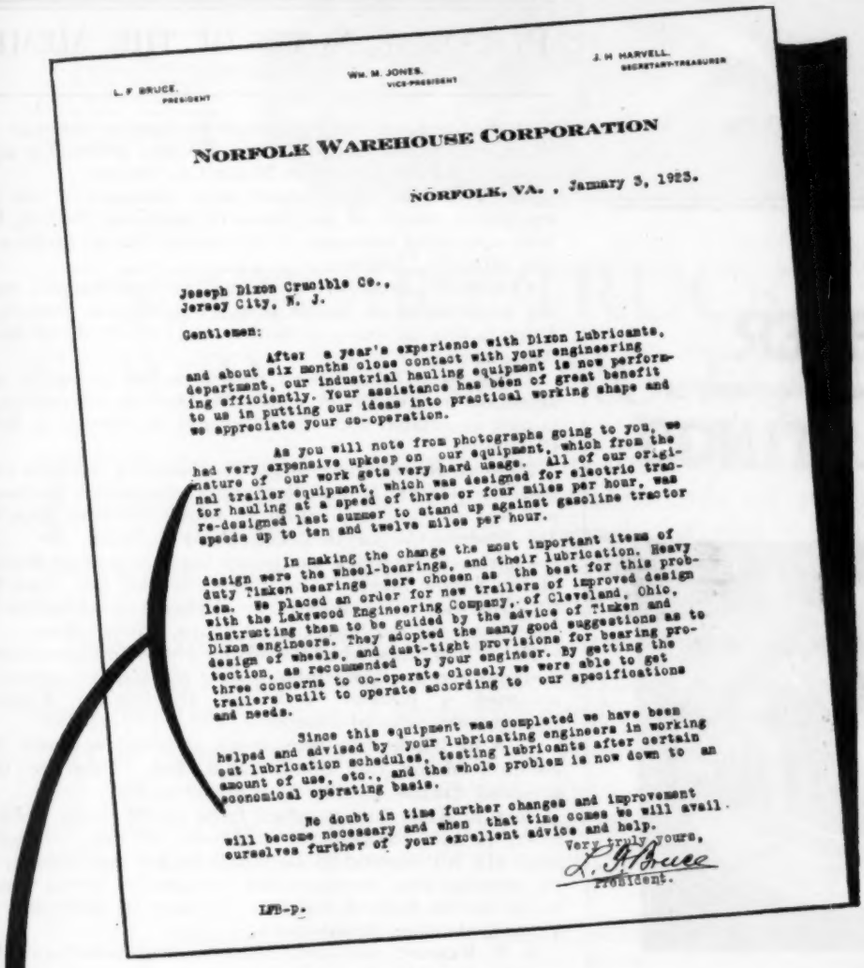
Stanley R. Cummings has been appointed research engineer for the Hoover Suction Sweeper Co., North Canton, Ohio. He was previously assistant professor of mechanical engineering at Lafayette College, Easton, Pa.

O. L. Curtis is now associated with the Checker Cab Mfg. Co., Kalamazoo, Mich., as salesman and supervisor of districts.

Frank Dunbar has accepted a position with the Ahrens-Fox Fire Engine Co., Cincinnati, and is engaged in assembling motors. He formerly attended the University of Cincinnati.

Samuel B. Eisenberg, who was until recently designer for the International Motor Co., New Brunswick, N. J., has accepted a position with the Durant Motors, Inc., Long Island City, N. Y.

(*Continued on p. 4*)



L. F. BRUCE, PRESIDENT — WM. M. JONES, VICE-PRESIDENT — J. H. HARVELL, SECRETARY-TREASURER

NORFOLK WAREHOUSE CORPORATION

NORFOLK, VA., January 3, 1923.

Joseph Dixon Crucible Co.,
Jersey City, N. J.

Gentlemen:

After a year's experience with Dixon Lubricants, and about six months close contact with your engineering department, our industrial hauling equipment is now performing efficiently. Your assistance has been of great benefit to us in putting our ideas into practical working shape and we appreciate your co-operation.

As you will note from photographs going to you, we had very expensive upkeep on our equipment, which from the nature of our work gets very hard usage. All of our original trailer equipment, which was designed for electric tractor hauling at a speed of three or four miles per hour, was re-designed last summer to stand up against gasoline tractor speeds up to ten and twelve miles per hour.

In making the change the most important items of design were the wheel-bearings, and their lubrication. Heavy duty Timken bearings were chosen as the best for this problem. We placed an order for new trailers of improved design with the Lakewood Engineering Company, of Cleveland, Ohio, instructing them to be guided by the advice of Timken and Dixon engineers. They adopted the many good suggestions as to design of wheels, and dust-tight provisions for bearing protection, as recommended by your engineer. By getting the three concerns to co-operate closely we were able to get trailers built to operate according to our specifications and needs.

Since this equipment was completed we have been helped and advised by your lubricating engineers in working out lubrication schedules, testing lubricants after certain amount of use, etc., and the whole problem is now down to an economical operating basis.

No doubt in time further changes and improvement will become necessary and when that time comes we will avail ourselves further of your excellent advice and help.

Very truly yours,
L. F. Bruce
President.

LFB-p.

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"No doubt in time further changes and improvement will become necessary and when that time comes we will avail ourselves further of your excellent advice and help."

The services of the Dixon Lubrication Engineers are also at ***your*** disposal for the solution of all your lubrication problems.

JOSEPH DIXON CRUCIBLE COMPANY

MAKERS OF QUALITY LUBRICANTS

JERSEY CITY NEW JERSEY

PERSONAL NOTES OF THE MEMBERS

Continued

O. E. Fishburn has been made production engineer for the Warner Gear Co., Muncie, Ind. He was previously assistant engineer for the Chevrolet Motor Co., Detroit.

R. P. Flower is no longer sales manager of the factory equipment branch of the Penco Corporation, Detroit, but has been appointed manager of the master burner division of the Gill Mfg. Co., Chicago.

Charles W. Frederick has joined the experimental engineering department of Dodge Bros., Hamtramck, Detroit, Mich. Prior to this he was a student at the University of Michigan, Ann Arbor.

James W. Graham, who was formerly inspector of construction in division of water for the city of Dayton, Ohio, is now associated with the Cleveland Motorcycle & Mfg. Co., Cleveland.

Miles G. Hanson has resigned as research methods engineer with the General Motors Research Corporation, Dayton, Ohio, and has accepted a position as works engineer with the Dé Jon Electric Corporation, Poughkeepsie, N. Y.

Charles E. Hartrick has joined the engineering department of the Yellow Sleeve Valve Engine Works, Inc., East Moline, Ill. He was until recently an engineer, working on textile machinery for the Saco Lowell Shops, Lowell, Mass.

M. O. Hodgkins, who was formerly tool and special machine designer for the Burroughs Adding Machine Co., Detroit, has accepted a position with the Commercial Engineering Laboratories, also of Detroit.

Finn T. Irgens has been made assistant engineer for the Johnson Motor Co., South Bend, Ind. Prior to this he attended Purdue University, Lafayette, Ind.

Bert F. Kelly has resigned from the Weidely Motors Co., where he held the position of director of sales and advertising. He will remain in Indianapolis for the present, where he contemplates representing automotive parts manufacturers in the Indiana district. He may be addressed at 733 Virginia Avenue, Indianapolis.

E. F. Kenney, who until recently was metallurgical engineer for the Midvale Steel & Ordnance Co., Philadelphia, has become associated with the Bethlehem Steel Co., Bethlehem, Pa., in a similar capacity.

P. J. Kent has become affiliated with the Chalmers plant of the Maxwell Motor Co., Detroit. He was previously electrical engineer for the Zeder-Skelton-Breer Engineering Co., Newark, N. J.

Wellington P. Kidder has been appointed consulting engineer for Rochester Industries, Inc., Rochester, N. Y. His former business connection was as designer and consulting engineer for the Leggatt Portable Typewriter Co., New York City.

G. F. Kolb is now manager of the bumper division of the Bullard Machine Tool Co., Bridgeport, Conn. Until recently he held the corresponding position in the now inactive motorcycle division of that company.

I. M. Lewis, who has been associated with the Bessemer Motor Truck Co., Grove City, Pa., as treasurer and manager, is now general sales manager of that company.

R. P. Lewis, who formerly was associated with the Dayton-Wright Co., Dayton, Ohio, as airplane and seaplane designer, has accepted a position on the engineering staff of the LaFayette Motors Corporation, Milwaukee.

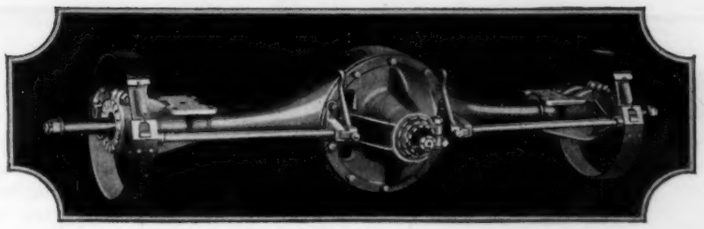
William C. Marshall has severed his connection with the Trexler Co. of America, Wilmington, Del., where he was mechanical engineer in charge of engineering and inspection. His future plans have not been announced.

C. S. Moody on Aug. 1 became associated with the C. L. Best Tractor Co., San Leandro, Cal. He was previously metallurgical engineer for the Minneapolis Steel & Machinery Co., Minneapolis.

Joseph Moosbrugger has accepted a position as plant engineer with the National Aniline & Chemical Co., Buffalo. He was formerly automobile body designer for the Associated Motor Industries, Inc., Dayton, Ohio.

(*Concluded on p. 6*)

S. R. B. new type Annular Ball Bearings, both single and double row, are standard equipment on many of America's most representative pleasure cars and commercial trucks.



This Clark Equipment Company Rear Axle Construction —B-306— for the Stewart 1-ton Truck has S. R. B. Annular Ball Bearings on the pinion for quiet, frictionless service.

STEWART TRUCKS HAVE S. R. B. BEARING EQUIPMENT

IN producing a one-ton truck to meet the needs of speedy, reliable delivery by thousands of manufacturers and merchants throughout the United States, the Stewart Motor Corporation designed the well-known Stewart 1-ton Speed Truck Model 16.

Speed, freedom from repair and overhaul, economical operation and maintenance costs, reliable every-business-day performance were the cardinal requirements.

It is significant that S. R. B. Bearings are used in the pinion position of the rear axle construction and are delivering their proportionate share of efficiency to the general excellence of this remarkable light truck.

STANDARD STEEL AND BEARINGS INCORPORATED
PLAINVILLE CONN.
U. S. A.

S. R. B. Bearings are serviced by the branches of the Standard Sales and Service Co. throughout the country

SRB

Stewart
1-TON TRUCK
MODEL 16

PERSONAL NOTES OF THE MEMBERS

Concluded

Moritz Nielsen is no longer assistant engineer for the Phelps Light & Power Co., Rock Island, Ill., but is now associated with the Climax Engineering Co., Clinton, Iowa.

Gen Ohsawa has become affiliated with the Buick Motor Co., Flint, Mich., as engineer and is doing work in connection with the design of a factory building and its equipment.

Benjamin S. Pfeiffer, who maintains offices in the First National Bank Building, Chicago, has been appointed consulting engineer for the A. J. Detlaff Co. of Detroit.

W. E. Richard has accepted a position as chief engineer with the Sunbeam Electric Mfg. Co., Evansville, Ind. His previous business connection was with the Midwest Engine Co., Indianapolis, as tractor engineer.

John W. Ruzicka has been appointed sales and advertising manager of the Premier Electric Co., Chicago.

Charles S. Slaker, who was formerly general manager of the Hayes Wheel Co., Jackson, Mich., has been made president of the Premier Sales Co., Indianapolis.

Lon R. Smith has been appointed general manager, in charge of sales and advertising of the Lubac Corporation, Chicago. Prior to this he was vice-president of the Mid-West Engine Co., Indianapolis, and more recently consulting engineer for the Bishop & Babcock Co., Cleveland.

Berger Stockfleth has joined the automotive experimental department of the Clark Equipment Co., Buchanan, Mich., as chief engineer. He previously held a similar position with the International Harvester Co., Chicago.

G. A. Strom is no longer designer for the Western Electric Co., Cicero, Ill., but is connected with the Sinclair Refining Co., Chicago, in a similar capacity.

Raymond E. Swanson, who attended Purdue University, Lafayette, Ind., until recently, has accepted a position as student engineer with the Worthington Pump & Machinery Corporation, Cincinnati.

Loyal George Tinkler has been appointed research chemist, doing alloy development work for the S. S. White Dental Mfg. Co., Prince Bay, Staten Island, N. Y.

Guy W. Vaughan resigned on Aug. 1 as president of Standard Steel & Bearings, Inc., Philadelphia, and vice-president and operating head of the Marlin-Rockwell Corporation, New York City. His plans for the future have not been made known.

J. H. Weller has severed his connection with the Herschell-Spillman Motor Co., North Tonawanda, N. Y., where he was factory manager, and has joined the Gray Motor Co., Detroit, in a similar capacity.

Albert B. Werdehoff has become associated with the Zeder-Skelton-Breer Engineering Co., Newark, N. J.

Donald E. Willard, who was formerly president and treasurer of the Decatur Malleable Iron Co., Decatur, Ill., is now associated with the Danville Malleable Iron Co., Danville, Ill.

Notes and Reviews

In this column are given brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

SOME FATIGUE TESTS OF SPRING STEELS. By R. E. Lewton. Published in *Transactions of American Society for Steel Treating*, June, 1923, p. 944. 11 illustrations.

The author of this paper presents some very interesting data obtained in the testing of leaf springs for automotive purposes and outlines the procedure and the results obtained in testing five different types of steel.

PACKARD MODEL 1551 300-HP. AIRSHIP ENGINE. By J. G. Vincent. Published in *Aviation*, June 25, 1923, p. 686.

An illustrated article giving the details and general characteristics of the engines to be used on the Navy Airship Z R 1, that is now under construction at Lakehurst, N. J.

THE DETECTION, LOCATION AND COMPARISON OF SOUND. By C. E. Noel-Storr. Published in *Engineering Production*, June, 1923, p. 301.

Is an extract from a paper presented to the Newark Branch of the Institution of Production Engineers containing a description of the Sonometer and its use in the investigation of sounds in machinery.

SUPERCHARGING SMALL ENGINES. Published in *The Autocar*, June 22, 1923, p. 1103.

Gives an account of tests in Great Britain on a Mercedes stock car equipped with a supercharger. A considerable increase in power is reported for the supercharged engine.

TEST TO DETERMINE MINIMUM FUEL-HEAD TO OPERATE LIBERTY 12 ENGINE ON PROPELLER LOAD. By J. M. Miller. Air Service Information Circular No. 422. Published by the Government Printing Office, City of Washington.

The conclusions brought out by this report are that the minimum fuel-head required varies from ½ in. of fuel at extreme idling to 16 in. at full throttle and 1700 r.p.m. for carbureters that give a mixture which is sufficiently rich to produce smooth operation over the entire range of speeds; that if the carbureters give a lean enough mixture at any speed to produce rough operation of the engine, the head required at that speed may exceed that at full throttle.

AIRWAYS AND LANDING FACILITIES. Air Service Information Circular No. 404. Published by the Government Printing Office, City of Washington.

Contains information for pilots concerning the airways, landing-fields, markers and landing facilities of the United States.

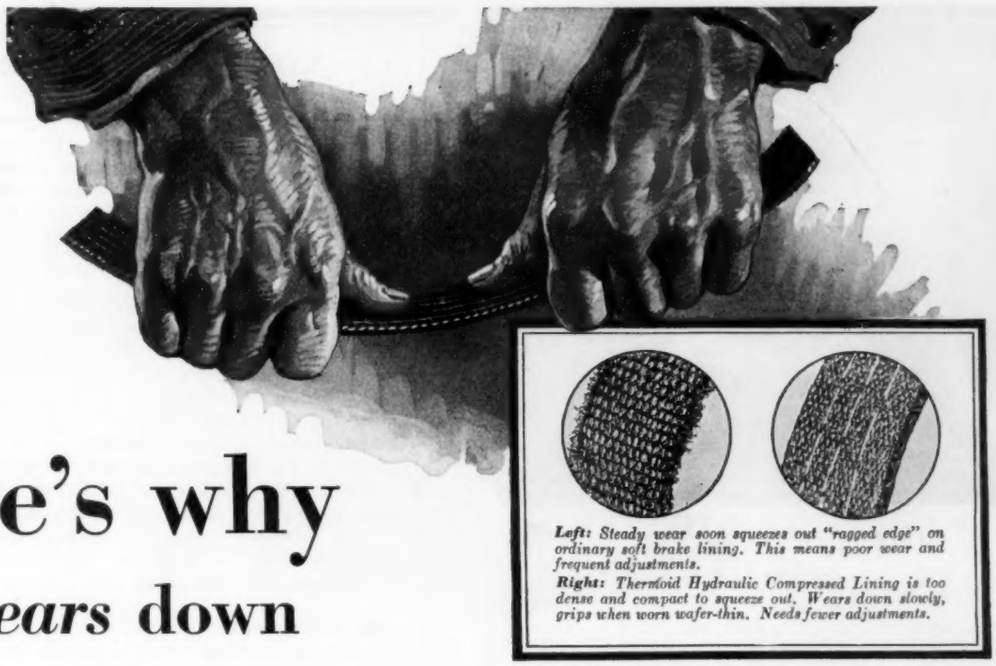
DESIGN CHARACTERISTICS FOR MOST SUITABLE PURSUIT AIRPLANES. By Leslie MacDill and F. W. Herman. Air Service Information Circular No. 436. Published by the Government Printing Office, City of Washington. 7 pp.

The object of the study discussed by this pamphlet is the selection of the most suitable engine, wing section and wing loading to obtain the most desirable performance for single-seater, low-altitude, water-cooled, pursuit airplanes. Nine illustrations showing plots of test results supplement the text.

DESCRIPTION OF CARBURETER TEST CHAMBER AND METHOD OF MAKING COMPUTATIONS. By J. M. Miller. Air Service Information Circular No. 405. Published by the Government Printing Office, City of Washington. 16 pp., including 6 tables and 11 illustrations.

This circular describes in considerable detail the carbureter test chamber of the engineering division of the Air Service. The installation includes, besides the chamber itself, a pump for creating a suitable air flow and other apparatus and instruments required to reproduce actual flight conditions in the laboratory and to make the necessary measurements for use in computations. The procedure of testing and of computing test results is outlined at the conclusion of the circular.

(*Continued on p. 10*)



Left: Steady wear soon squeezes out "ragged edge" on ordinary soft brake lining. This means poor wear and frequent adjustments.

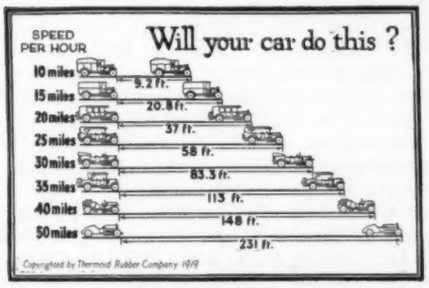
Right: Thermoid Hydraulic Compressed Lining is too dense and compact to squeeze out. Wears down slowly, grips when worn wafer-thin. Needs fewer adjustments.

Here's why it *wears* down slowly instead of *mashing* down quickly

Take a short strip of Thermoid Compressed Brake Lining. See how compact it is, as compared to an ordinary lining. Feel its density, its weight. This solid compactness makes Thermoid grip evenly and wear longer.

Tremendous hydraulic pressure — 2000 pounds of it — takes all further "give" out of Thermoid. In its place is compressed *40% more material* than is found in any other brake lining made.

This compression makes Thermoid *wear* down slowly instead of *mashing* down quickly.



Famous Thermoid Standard Chart—shows distances in which car should stop if brakes are efficient. Brakes lined with Thermoid meet these standards.

Thermoid doesn't "squeeze out"

The tremendous hydraulic pressure on Thermoid takes out all excess "give." That is why Thermoid is the last to show the "ragged edge" between drum and brake band.

Send for our booklet, "The Dangers of Faulty Brakes." It contains valuable information and complete records of brake lining tests which every engineer will be glad to have on hand.

THERMOID RUBBER COMPANY

Factory and Main Offices: Trenton, N. J.

New York, Chicago, Los Angeles, Detroit, Atlanta, San Francisco, Boston, Cleveland, Kansas City, Seattle London, Paris, Turin

Thermoid Brake Lining

Hydraulic Compressed

Makers of "Thermoid-Hardy Universal Joints" and "Thermoid Crolide Compound Tires"

NOTES AND REVIEWS

Continued

AN APPARATUS AND METHOD FOR THE DETERMINATION OF THE RESISTANCE TO ABRASION OF RUBBER PRODUCTS. By W. W. Evans. Preprint of a paper presented at the 1923 annual meeting of the American Society for Testing Materials. Published by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia. 5 pp.; 2 illustrations; 1 table.

Perhaps the chief advantage claimed for the abrasion-testing machine and the method described in the paper is that reasonably dependable and consistent results are obtainable from rubber test-specimens. Manufacturers of rubber articles should be interested in the design of the apparatus and the method employed by the author in determining the resistance of rubber to abrasion.

RESISTANCE OF MANGANESE BRONZE, DURALUMIN AND ELECTRON METAL TO ALTERNATING STRESSES. By R. R. Moore. Preprint of a paper presented at the 1923 annual meeting of the American Society for Testing Materials. Published by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia. 17 pp.; 8 illustrations; 2 tables.

Included in this paper are the results of an investigation made by the engineering division of the Air Service to determine the endurance limit of duralumin bar stock as rolled, annealed and tempered. The endurance limits of the metals tested are given, and several conclusions are drawn with regard to the properties of non-ferrous metals.

REPORT OF SUB-COMMITTEE IX ON VARNISH. Presented at the 1923 annual meeting of the American Society for Testing Materials. Published by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia.

Gives the results of exposure tests on varnishes; also the proposed tentative methods of testing oleo-resinous varnishes.

REPORT OF COMMITTEE D-1 ON PRESERVATIVE COATINGS FOR STRUCTURAL MATERIALS. Presented at the 1923 annual meeting of the American Society for Testing Materials. Published by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia. 60 pp.

Reports from sub-committees on Testing of Paint Vehicles, Definitions of Terms Used in Paint Specifications, Methods of Analysis of Paint Materials, Shellac, Preparation of Iron and Steel Surfaces for Painting, Physical Properties of Paints and Anti-Fouling Paints are included.

REPORT OF COMMITTEE D-2 ON PETROLEUM PRODUCTS AND LUBRICANTS. Presented at the 1923 annual meeting of the American Society for Testing Materials. Published by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia.

Contains recommendations and proposed tentative methods for various tests of oils; gives reports of sub-committees on petrolatum, grease, color, distillation, oxidation at high temperatures, emulsification, flash, organic acidity and saponification, sampling and gaging.

REPORT OF COMMITTEE D-4 ON ROAD AND PAVING MATERIALS. Presented at the 1923 annual meeting of the American Society for Testing Materials. Published by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia.

Suggests desirable changes in certain tentative and standard methods and specifications and mentions a number of new methods and specifications as tentative.

FURTHER STUDIES OF THE PHYSICAL PROPERTIES OF DRYING-OIL, PAINT AND VARNISH FILMS. By Harley A. Nelson and George W. Rundle. Preprint of a paper presented at the 1923 annual meeting of the American Society for Testing Materials. Published by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia. 14 pp.; 6 illustrations; 3 tables.

Contains a discussion of the fundamental properties of protective paint coatings and outlines tests whereby they can be determined.

(*Continued on p.* 12)

NOTES AND REVIEWS

Continued

GLIDING AND SOARING FLIGHT. By J. Bernard Weiss. Published by Sampson Low, Marston & Co., Ltd., London. 164 pp.; 13 illustrations.

A historical treatment of gliding development and experimentation, brought uptodate. Descriptions of the various types of glider, as well as a consideration of theoretical aspects of gliding and soaring flight, are included.

AIRCRAFT YEAR BOOK, 1923. Compiled by Charles E. Lee, edited by C. G. Grey. Published by Sampson Low, Marston & Co., Ltd., London. 182 pp.; illustrated.

A well-arranged compilation of useful information concerning airways of the world, operating companies, rates, schedules, etc. The book contains also a short glossary of aeronautical terms and several chapters relating to air legislation, regulations and other pertinent matters.

RECENT DEVELOPMENTS OF THE MOTOR COACH. By C. E. Brooks. Published in *Mechanical Engineering*, August, 1923, p. 463. 3 illustrations.

Outline of transportation requirements for given hauls; details of motor coach design and service over lines in Canada.

THE WIND FACTOR IN FLIGHT: AN ANALYSIS OF ONE YEAR'S RECORD OF THE AIR MAIL. By Willis Ray Gregg and Lieut. J. Parker Van Zandt. Published by Government Printing Office, City of Washington. 15 pp.; 7 illustrations; 14 tables.

A very interesting report relating to a study of winds and general meteorological conditions on the Air Mail Route between New York City and San Francisco, with especial reference to the portion between New York City and Chicago. In addition to making a practical analysis of air conditions and their relation to flying activities, the authors of this paper, which was printed in the *Monthly Weather Review*, March, 1923, very properly emphasize once more the splendid record of the Air Mail Service. It is pointed out that (*a*) from July 16, 1921, until Sept. 7, 1922, Air Mail pilots flew approximately 2,000,000 miles without a fatal accident, and (*b*) during the fiscal year ended June 30, 1922, an efficiency of service of 94.39 per cent was maintained.

AERONAUTIC INSTRUMENTS. Bureau of Standards Technologic Paper No. 237. By Franklin L. Hunt. Published by the Government Printing Office, City of Washington. 55 pp.; illustrated.

The purpose of this paper is to describe briefly the various types of aircraft instrument which have reached a state of development such that they have found extensive use in service. A general description of representative instruments of the various types is given, which will be useful to a person who wishes to familiarize himself with the different instruments used on aircraft but is not interested in the mechanical details of their construction.

WHAT THE INDUSTRY SEES AHEAD FOR BALLOON TIRES. Published in *Tires*, July, 1923, p. 32.

THE SUPERCOMPRESSION AIRCRAFT ENGINE, A THEORETICAL CONSIDERATION OF THE FACTORS INVOLVED. Published in *The Automobile Engineer*, July, 1923, p. 206.

TOOTH PRESSURE CALCULATIONS. By R. H. Boyd. Published in *The Automobile Engineer*, July, 1923, p. 223.

RUBBER LATEX. By C. C. Loomis and H. E. Stump. Published in *Chemical and Metallurgical Engineering*, July 30, 1923, p. 184.

A report on the fundamental properties and behavior of latex, the sap of the rubber tree.

ILLINOIS HIGHWAY COMMISSION CONDUCTS IDEAL ROAD TEST. Published in *Motor Age*, July 26, 1923, p. 23.

A review of results of tests on the Bates Experimental Road.

MANUFACTURE OF AUTOMOBILE FRONT AXLES. By Edward K. Hammond. Published in *Machinery*, August, 1923, p. 939.

Machining operations on axle forgings, steering knuckles, and steering arms are described.

(*Continued on p.* 14)

NOTES AND REVIEWS

Continued

EXCEPTIONAL DURABILITY IS CLAIMED FOR NEW BODY FINISH. By Herbert Chase. Published in *Automotive Industries*, July 26, 1923, p. 158.

FLAT SPRINGS AND HOTCHKISS DRIVE FAVORED IN BUS DESIGN. By Alfred F. Masury. Published in *Automotive Industries*, July 26, 1923, p. 163.

Wide, thin leaves preferred to narrow thick ones. Important to use means for fastening springs securely to axle. Substitution of rubber blocks for metal shackles considered desirable. Track and wheelbase are largely determined by operating conditions.

INTEREST IN EIGHT-IN-LINE ENGINES CENTERS IN CRANKSHAFT LAYOUT. Published in *Automotive Industries*, July 26, 1923, p. 166.

RECENT GERMAN CARBURETER DESIGNS STRESS USE OF CHEAPER FUELS. By Benno R. Dierfeld. Published in *Automotive Industries*, July 26, 1923, p. 177.

RECLAIMING CRANKCASE OIL. By Forrest A. Hoff. Published in *Oil News*, July 20, 1923, p. 17.

THE INTERNATIONAL AIR CONGRESS. Published in *Aeronautical Engineering*, July 4, 1923, p. 17.

Under this title are presented brief abstracts of the papers presented at the meeting in London, June 25 to 30, 1923.

THE DILUTION OF LUBRICATING OIL. Published in *Motor Transport*, June 25, 1923, p. 771.

How to reduce the contamination of engine oil by fuel and water, which encourages failure and rapid wear of bearings.

DUST AND THE TRACTOR ENGINE. By A. H. Hoffman. Published by University of California Press, Berkeley, Cal. 18 pp.; illustrated.

Report of an investigation of cleaners to remove dust from the air entering a tractor engine.

OPERATING PRACTICE IN REFINING CRACKED PETROLEUM DISTILLATES. By Gustav Egloff and Jacque C. Morrell. Published in *Chemical and Metallurgical Engineering*, July 9, 1923, p. 53.

How the sulphuric-acid and sodium plumbite treatments are modified to handle the products of cracking processes.

THE RICKENBACKER FOUR-WHEEL BRAKING SYSTEM. Published in *Motor*, July, 1923, p. 42, illustrated.

A NEW HYDRAULIC FOUR-WHEEL BRAKING SYSTEM. Published in *Motor*, July, 1923, p. 47.

Refers to Lockheed system.

WHAT ARE FUNDAMENTAL FACTORS WHICH GOVERN MOTOR BUS DESIGN? By Alfred F. Masury. Published in *Automotive Industries*, July 19, 1923, p. 112.

In this article the author deals with the considerations that govern the general nature of the chassis, the size and the character of the engine, the type of final drive, the factors that govern the frame height, the optimum design and the arrangement of the brakes and the most favorable type of tire and wheel equipment.

NEW SPRING DESIGN MAKES MASTER LEAF THINNER THAN SHORTER PLATES. Published in *Automotive Industries*, July 19, 1923, p. 117.

Discussion of leaf-spring design with special reference to the Landau spring.

NEW THEORY WOULD RATE BALL BEARINGS ON ENDURANCE LIMIT. By A. W. Macaulay. Published in *Automotive Industries*, July 19, 1923, p. 130.

NEW DEVICE MEASURES VOLUME OF HIGHWAY TRAFFIC. Published in *Automotive Industries*, July 12, 1923, p. 63.

Brief description of device developed by engineers of the Bureau of Public Roads to record automatically the number, the weight and the speed of vehicles passing over it, when installed in the highway.

PISTON DISPLACEMENT FACTORS FOUND FOR MOTOR TRUCKS. By P. M. Heldt. Published in *Automotive Industries*, July 12, 1923, p. 66.

Relation to the vehicle loaded weight, the driving-wheel diameter and the direct-gear drive-ratio discussed. Analysis

(*Concluded on p.* 16)

NOTES AND REVIEWS

Concluded

follows the lines of a similar study previously made for passenger cars. Trucks are divided into four separate groups on a rated tonnage basis.

FORMULAS SHOW PROPER TIRE PRESSURES. By H. W. Slauson. Published in *Automobile Topics*, July 14, 1923, p. 877.

Safe limits fixed by manufacturers; recommended pressures derived by simple calculation.

THE CLAIMS OF THE SLEEVE-VALVE. Published in *The Light Car and Cyclecar*, July 6, 1923, p. 188.

ENGINE WEAR AND HEAVIER OILS. By A. B. Dawson. Published in *Motor Record*, July, 1923, p. 12.

The author of this paper finds the selection of engine lubricants on a mileage basis unsound for four reasons: (*a*) the clearance enlargement is not proportional to the car mileage, (*b*) the rate of enlargement is not constant for all engines, (*c*) the selection of the proper oil does not depend wholly on the clearance and (*d*) with an excessive enlargement of the clearance no oil can effectively seal the piston-rings.

THE STUDY OF HARDNESS. By C. A. Edwards. Published in *Engineering Production*, July, 1923, p. 320.

A paper describing a hardness investigation in which a Shore scleroscope modified by replacing the usual falling body with a 10-mm. steel ball was used. The work outlined includes a determination of the relationship between (*a*) the heights of the fall and the rebound, (*b*) the heights of the fall and the volumes of the indentations produced, (*c*) Brinell hardness numbers and the rebounds obtained from falls giving a certain constant volume of indentation, and (*d*) the Brinell hardness numbers and the rebounds obtained from a constant height of fall.

SAYBOLT VISCOSITY MEASUREMENTS AND THEIR CONTROL. By P. E. Klopsteg and W. H. Stannard. Published in *Industrial and Engineering Chemistry*, July, 1923, p. 702.

Description of the apparatus for maintaining uniform conditions of constant temperature in making viscosity measurements on oils.

CONSISTENCY DETERMINATION OF GREASES. By Charles B. Karns and Oscar L. Maag. Published in *Industrial and Engineering Chemistry*, July, 1923, p. 716.

Description of the apparatus and a method for classifying greases on a basis of their consistency or body.

SPIRAL BEVEL GEARS. By W. C. D. Published in *The Engineer*, June 29, 1923, p. 677.

This is the second section of an outline of gear design data; part one appeared in the issue of the same journal for June 22. Formulas are given for the Gleason type of spiral bevel gear.

BOUNDARY LUBRICATION IN ENGINEERING PRACTICE. By T. E. Stanton. Published in *The Engineer*, June 29, 1923, p. 678.

A report, covering the description of the apparatus and the tests, presented to the lubrication research committee of the Department of Scientific and Industrial Research.

SOME RECENT DEVELOPMENTS IN HARDNESS TESTING. By Edward G. Herbert. Published in *The Engineer*, June 29, 1923, p. 686.

Preliminary analysis of the results obtained with the Herbert pendulum hardness tester described in *The Engineer* of April 13, 1923.

INFLUENCES IN THE SELECTION OF A CYCLE FOR SMALL HIGH-SPEED ENGINES RUNNING ON SOLID OR AIRLESS INJECTION WITH COMPRESSION IGNITION. By Robertson Matthews. National Advisory Committee for Aeronautics. Technical Note No. 149, 15 pp., including 4 illustrations.

FACTORS GOVERNING THE STRENGTH OF GEAR TEETH. By Douglas T. Hamilton. Published in *American Machinist*, June 21, 1923, p. 907.

The third article in this series takes up the number of teeth and the tooth-ratio of gears in mesh; also, increasing the strength of pinions having a small number of teeth.


KERITE
A product of over fifty years distinguished service in the most important electrical fields, possessing inherent characteristics which make it pre-eminently desirable for
High Tension Automotive Ignition
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Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

C. M. Addis has become associated with the Refiners Lubricating Co., New York City. He was formerly vice-president of the National Lubricants Co., also of New York City.

F. G. Baender, who was previously professor of heat power engineering and superintendent of mechanics arts at the University of Arkansas, Fayetteville, has become associated with the Joseph W. Hays Corporation, Michigan City, Ind.

E. H. Belden has been made president and general manager of the E. H. Belden Co., Toledo. Until recently he was assistant to the president of the Willys-Overland Co., also of Toledo.

H. T. Booth has severed his connection with the Curtiss Aeroplane & Motor Corporation, Garden City, N. Y., and is now chief engineer for the Bee Line Aircraft Corporation, Hammondsport, N. Y.

Joseph Bornstein has resigned as vice-president, works manager and chief engineer for the American Metal Parts Co., Boston. His plans for the future have not been announced.

J. H. Brackenridge, who was formerly assistant to the manager of the Truck Engineering Co., Cleveland, is now secretary to the manager of the Ore & Coal Exchange, also at Cleveland.

C. Breer has become associated with the Maxwell Motor Corporation, Detroit. Prior to this he was engineer, secretary and treasurer of the Zeder-Skelton-Breer Engineering Co., Newark, N. J.

DeWitt Clausen, who was previously designer of engines for the Climax Engineering Co., Clinton, Iowa, has been made assistant engineer in the steam department of that company.

O. W. L. Coffin has been appointed manager of the Manford Cadillac Co., Houston, Tex. Until recently he was branch manager supervising service and sales for the White Co., Cleveland.

The offices of the Standard Steel & Bearings, Inc., of which **Lloyd A. Cummings** is chief engineer, have been removed from Philadelphia to Plainville, Conn.

W. H. Daniel has severed his connection with the George B. Miller & Son Co., Waterloo, Iowa, where he was chief engineer, and is now tool designer for the P. B. Yates Machine Co., Beloit, Wis.

A. L. Doerr is no longer president and general manager of the Clydesdale Motor Truck Co. of California, San Francisco, but has been appointed manager of the transportation division of the Star Motor Co. of California, Oakland.

Felix Doran, Jr., for several years connected with the Chevrolet Motor Co., Kansas City, Mo., as special representative, has received the appointment of assistant to the sales manager of that company at Oklahoma City, Okla.

(*Continued on p. 4*)

PERSONAL NOTES OF THE MEMBERS

Continued

C. M. Eason has been appointed assistant to the president of the General Motors Corporation, Detroit.

Warren H. Farr, who was formerly general superintendent for the Durant Motor Co. of Indiana, Inc., Muncie, Ind., has accepted a position as factory manager for the Flint Motor Co., Flint, Mich.

Henry Farrington has been made advertising manager of the Mason Tire & Rubber Co., of New York, Inc., Kent, Ohio. He was previously associated with the Better Tires Co., Chicago.

E. Favary, who was formerly a consulting engineer and president of the Favary Tire & Cushion Co., 17 West 42nd Street, New York City, is now located in Los Angeles.

George T. Felbeck has become associated with the Linde Air Products Co., Buffalo, N. Y. Until recently he was research assistant in mechanical engineering at the University of Illinois Engineering Experiment Station, Urbana.

Melvin L. Fish has accepted a position as chassis layout draftsman for the H. H. Franklin Mfg. Co., Syracuse, N. Y. Prior to this he was chief draftsman for the Fox Motor Car Co., Philadelphia.

H. DeLong Fry has been appointed general sales manager of the Apollo Magneto Corporation, Kingston, N. Y. He was previously assistant sales manager of the Bedford Chevrolet Sales Corporation, Brooklyn, N. Y.

Otis E. Griner is now assistant to the general manager in charge of sales and advertising for the Lubac Corporation, Chicago. Until recently he was sales and service engineer for the Midwest Engine Co., Indianapolis.

William R. Grundmann, who was previously connected with the road test department of the Mercer Motors Co., Trenton, N. J., has become affiliated with the Paige & Jewett Service, Redondo Beach, Cal.

N. F. Hadley, who was mechanical engineer engaged in design, research and experimental work for the Zeder-Skelton-Breer Engineering Co., Newark, N. J., is now affiliated with the Chalmers plant of the Maxwell Motor Corporation, Detroit.

Sezo Hatashita is now connected with the Trail Ford Corporation, Ann Arbor, Mich. He was until recently chief engineer for the Transportation Equipment Co., Detroit.

Lewis W. Heath, who was formerly manager of the Industrial Engineering Co., Grand Rapids, Mich., has been made division manager of the Pennsylvania Power & Light Co., Allentown, Pa., and will make his headquarters at Williamsport, Pa.

George A. Holmes has accepted a position as shop engineer with the Dodge Bros. Motor Car Co., Detroit. He previously attended the University of Michigan, Ann Arbor.

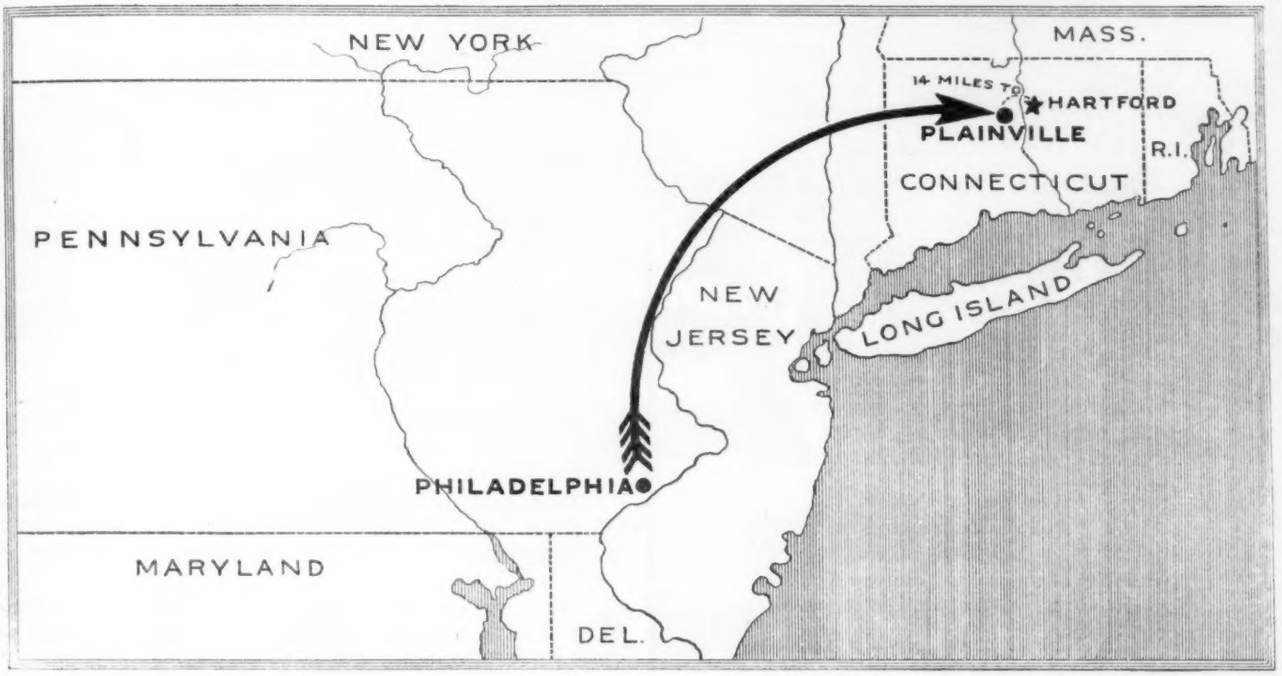
Milton O. Jensen has become service engineer for the Foxboro Co., Los Angeles, Cal. Prior to this he was affiliated with the Kaw Engravers, Kansas City, Kan.

Simon Kaplan has severed his relations with the Motor Parts Corporation, Baltimore, where he was vice-president and manager. His plans for the future have not been announced.

Adolph Klein has accepted a position as automotive layout draftsman for the Fifth Avenue Coach Co., New York City. He was previously manager of the Klein Printing Co., also of New York City.

(*Continued on p.* 6)

From PHILADELPHIA, PENNA. *To* PLAINVILLE, CONN. for a greater Service



THE entire Philadelphia plant and executive offices of the Standard Steel And Bearings Incorporated are now concentrated in its New England factory at Plainville, Connecticut.

With a service record of over 25 years in Philadelphia, it was a matter of regret on the part of the entire organization to leave the city where this Company was organized and brought to its present success. Our new, one-floor plant, however, allows for an unhampered arrangement of machine tools and equipment not possible in our former multi-storied plant in a congested city district.

Therefore no break in the steady, even production flow from raw material to finished product and an even more careful supervision through its many operations under a single, perfected inspection plan.

At Plainville with larger, more spacious facilities S.R.B. Bearings will continue to be produced in the same High Quality of Design and Materials that have designated them "the ultimate in Ball Bearings".

SRB

STANDARD STEEL AND BEARINGS INCORPORATED

PLAINVILLE U. S. A. CONNECTICUT

S.R.B. Bearings are serviced by the branches of the Standard Sales and Service Co., throughout the United States

PERSONAL NOTES OF THE MEMBERS

Continued

Victor W. Kliesrath has opened an office at 120 Broadway, New York City, for the practice of consulting engineering.

Frank W. La Vista is now connected with the Air Service as aeronautical mechanical engineer and is stationed at the plant of the Steel Products Engineering Co., Springfield, Ohio. He was formerly experimental engineer for the L. W. F. Engineering Co., College Point, N. Y.

G. J. Lux, who was until recently chief engineer for the Detroit Gear & Machine Co., Detroit, is now engineer in the axle and transmission division of the Buick Motor Co., Flint, Mich.

Roy F. McGeady has been appointed inspector for the Western Electric Co., New York City.

A. E. Mannien has accepted a position as salesman for the Virginia Bottling Co., Virginia, Minn.

W. F. Milward has become associated with the Hampton Engineering Co. (1920), Ltd., Dudbridge, Stroud, England, as general manager and engineer. He was previously chief engineer for W. S. Laycock, Ltd., Millhouses, Sheffield, England.

M. V. T. Miners is now affiliated with Warren Webster & Co., Chicago. He formerly attended the University of Illinois, Urbana.

Emil Mraz, who until recently was superintendent for the Temme Spring Co., Chicago, has been appointed operating superintendent in charge of production for the American Auto Parts Co., Detroit.

W. O. Munroe has resigned as vice-president of the Standard Steel & Bearings, Inc., and has become associated with the National Aniline Chemical Co., Buffalo.

Toshio Nishioka, who was previously research engineer for the Shibaura Engineering Works, Tokyo, Japan, has been made merchandising manager for that company.

Joseph E. Padgett is no longer sales engineer for the Weidely Motors Co., and vice-president of the Carbureter & Accessories Co., Indianapolis, but is now representing the Beneke & Kropf Mfg. Co., Chicago, as sales engineer with offices in Detroit.

L. A. Paradise has been made superintendent of experiments for the John Deere Harvester Works, East Moline, Ill. His previous business connection was with the Waterloo Gasoline Engine Co., Waterloo, Iowa, as superintendent.

O. M. Peters has been appointed secretary and general manager of the Waynesboro Nut Lock Co., Inc., Waynesboro, Pa. He was formerly general works manager for the American Road Machinery Co., Kennett Square, Pa.

George R. Petrie, who was previously sales engineer for the Detroit Trailer Co., Detroit, has been made assistant superintendent of the St. Johns Table Co., Cadillac, Mich.

J. M. Pratt has become sales engineer in charge of the truck department for the Pond Co., Ltd., Honolulu, T. H. He was formerly in charge of automotive equipment for the Ewa Plantation Co., Oahu, T. H.

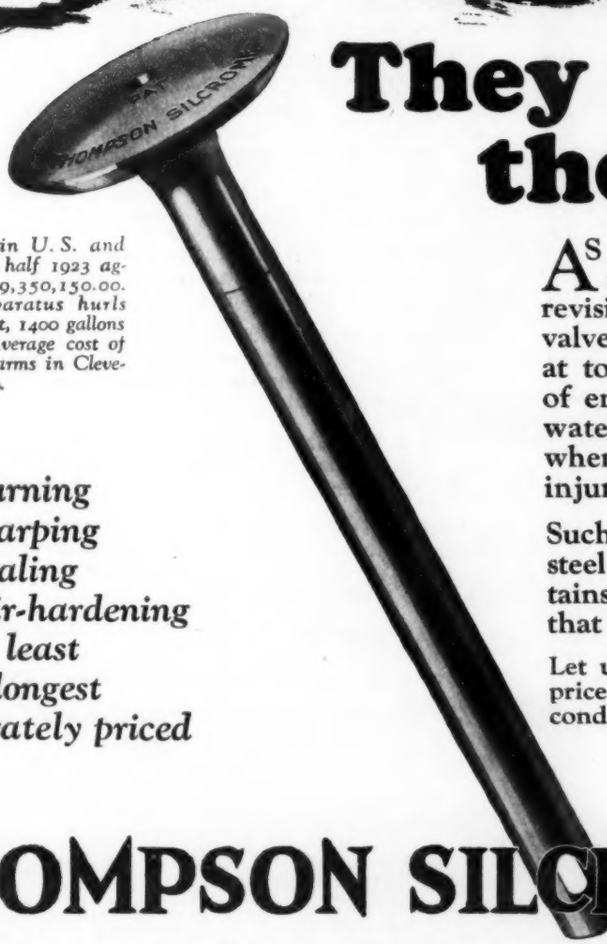
Harry E. Radack has severed his connection with the Lawrance Aero-Engine Corporation, New York City, where he was purchasing agent. No announcement has been made of his future plans.

W. D. Rheutan has been transferred from the main office of the White Motor Co. at Cleveland, where he was manager of the statistical division of the general service department, to the Louisville, Ky., office of the company as service-manager and assistant sales manager.

(*Continued on p.* 8)

They stand the strains!

Fire losses in U. S. and Canada first half 1923 aggregate $199,350,150.00. Modern apparatus hurls water 300 feet, 1400 gallons a minute. Average cost of answering alarms in Cleveland, $700.00.



Non-burning
Non-warping
Non-scaling
Non-air-hardening
Weigh least
Wear longest
Moderately priced

As standard equipment in finest fire-fighting apparatus, Thompson Silcrome Valves are revising old ideas of "how much punishment a valve will take". The terrific strains of fast hauls at top speed, the unusually sudden changes of engine temperatures, and long periods of water pumping in this field of service, as elsewhere, have yet to produce first evidence of injury to valves of Thompson Silcrome.

Such ruggedness can be possible only in the steel that is impervious to red heat, that contains no internal strains to cause warpage and that has remarkable wear-resistance.

Let us demonstrate the stamina of this moderately priced master valve in your own test engines—under conditions you specify.

—built by a "trail-breaker of industry"

THOMPSON SILCROME VALVES

THE STEEL PRODUCTS COMPANY

MAIN PLANT
CLEVELAND

Also manufacturers of king bolts, shackle bolts, tie rod bolts, drag links, starting cranks, and brake rod assemblies

MICHIGAN PLANT
DETROIT

PERSONAL NOTES OF THE MEMBERS

Continued

Albert E. Ruff, who formerly attended Ohio State University, Columbus, has accepted a position as sales engineer for the Ingersoll-Rand Co., New York City and Phillipsburg, N. J.

F. Saltzmann has resigned as tool designer for the Buick Motors, Flint, Mich. His plans for the future have not been announced.

Earl V. Schaal is no longer metallurgist for the engineering division of the Air Service, McCook Field, Dayton, Ohio, but now holds a similar position with the Elliott-Fisher Co., Harrisburg, Pa.

Louis J. Schneider, who was formerly sales manager for the Clark Tructractor Co., Buchanan, Mich., has accepted a similar position with the C. G. Spring Co. of Michigan, with offices at Detroit.

Pierre Schon, for 9 years connected with the General Motors Truck Co., Pontiac, Mich., in various capacities as service manager, sales representative and district sales manager, has severed his connection with that organization, and is now manager of the Shreveport GMC Truck Co., Shreveport, La.

Frank B. Sellards has become affiliated with the Stromberg Motor Devices Co., Chicago, in the capacity of experimental draftsman. He previously attended the University of Kansas, Lawrence.

John H. Shoemaker, who was formerly general manager of the Electric Battery Service Co. of Michigan, Detroit, has been appointed distribution manager for the Allyne-Zerk Co., Cleveland, with offices in the Basso Building, Detroit.

E. F. Smeckel has accepted a position as engineer with the American Steam Truck Co., Elgin, Ill.

Charles F. Smith has become associated with the Sterling-Knight Co., Warren, Ohio. He was previously in the design department of the White Motor Co., Cleveland.

Porter E. Stone, who was until recently consulting body engineer for the Highland Mfg. Co., Cincinnati, has been appointed salesman in the Chicago territory for the Eberhard Mfg. Co., Cleveland.

Mark J. Terman has accepted a position as apprentice engineer with the Babcock & Wilcox Co., Barberton, Ohio. Prior to this he attended Purdue University, Lafayette, Ind.

Louis Thoms has joined the engineering department of Graham Bros., Evansville, Ind. His previous business connection was with the Advance-Rumely Co., Battle Creek, Mich., as truck engineer.

E. J. Tiedemann, who until recently was works manager for the Milburn Wagon Co., Toledo, Ohio, has become affiliated with the Maxwell Motor Corporation, Dayton, Ohio.

Glenn A. Toaz has organized the Ashtabula Mfg. Co., Ashtabula, Ohio, of which he is president. Prior to this he was service engineer with the Steel Products Co., Cleveland.

G. R. Wadsworth has become associated with the Conlon Corporation, Chicago, Ill.

Paul Weeks, who was formerly assistant director of engineering for the Holt Mfg. Co., Stockton, Cal., has accepted an appointment as automotive engineer for the Ordnance Department and is located at Aberdeen Proving Ground, Md.

A. B. Werdehoff has accepted a position as chassis designer for the Chalmers Motor Co., Detroit. He was previously connected with the Zeder-Skelton-Breer Engineering Co., Newark, N. J.

(*Concluded on p.* 10)

Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

Charles J. Birmingham has severed his connection with the Locomobile Co., New York City, where he was superintendent. His plans for the future have not been announced.

Clement Booth has accepted a position as chief engineer with the Robbins Machine Works, Worcester, Mass.

M. C. Burnside, general sales manager for the Ireland & Matthews Mfg. Co., Detroit, has severed his connection with that company. No announcement has been made of his future plans.

C. R. Burt has resigned as president and general manager of the New Process Gear Corporation, Syracuse, N. Y., and is now associated with the Austin Machinery Corporation, Toledo.

Warren H. Burtis has severed his connection with the Marshall-Wells Co., Portland, Ore., where he was lubrication engineer. His plans for the future have not been announced.

Walter L. Carver has been appointed field editor specializing in production and manufacturing matters for the Class Journal Co., New York City. He will make his headquarters in Detroit.

Opie Chenoweth, who was formerly carburetion research assistant in the Engineering Experiment Station of Purdue University, West Lafayette, Ind., has received the appointment of service test engineer in the powerplant section of the engineering division of the Air Service, McCook Field, Dayton, Ohio.

C. W. Claassen has severed his connection with the Bauer Auto Sales Co., Cincinnati, Ohio. No announcement has been made of his future plans.

O. H. Clark, who was until recently body engineer for the Zeder-Skelton-Breer Engineering Co., Newark, N. J., is now associated with the Chalmers plant of the Maxwell Motor Corporation, Detroit.

Ralph R. Clark is no longer associated with the Clark Battery & Ignition Service, San Pedro, Cal. His plans for the future have not been announced.

R. H. Cosgrove, who was formerly chief draftsman for the Rubay Co., Cleveland, has accepted a position as body designer for the Studebaker Corporation, Detroit.

John F. Cox has accepted a position as technical apprentice with the White Motor Co., Cleveland.

Charles Ethan Davis has sailed for Paris where he plans to stay indefinitely. He was formerly general manager of the Eisemann Magneto Corporation, Brooklyn, N. Y.

Arthur M. Dean, who was formerly chief engineer for the Rubay Co., Cleveland, has become engineer for the Swan Carbureter Co., also of Cleveland.

James Dykstra has been appointed designing engineer for the Brooks Steam Motors, Ltd., Toronto, Ont. He was formerly designer for the Oakland Motor Car Co., Pontiac, Mich.

(*Continued on p. 4*)

PERSONAL NOTES OF THE MEMBERS

Continued

H. J. Edwards, who was until recently second vice-president and factory manager of the Cole Motor Car Co., Indianapolis, has become associated with the Willys-Overland Co., Toledo.

A. W. Einstein severed his connection as district sales manager for the Service Motors, Inc., Wabash, Ind., on Oct. 1. No announcement has been made of his future plans.

E. V. Elconin is now associated with the engineering department of the Timken-Detroit Axle Co., Detroit. He was formerly chief engineer for the Eaton Axle Co., Cleveland.

Ernest A. Elliott has severed his relations with the Motor Bearings Division of the Hyatt Roller Bearing Co., Detroit. His plans for the future have not been announced.

Armin Elmendorf has become affiliated with Vickers, Ltd., London. He was formerly consulting engineer for the Haskelite Mfg. Corporation, Chicago.

H. K. Gandelot, who until recently was service manager for the B. W. Lemmon Co., Pittsburgh, has joined the experimental department of the Rickenbacker Motor Co., Detroit.

Victor Gauvreau has resigned as assistant professor of mechanical engineering at the University of Minnesota, Minneapolis. His plans for the future have not been made known.

C. C. Hanch has opened an office in Indianapolis for the practice of commercial engineering. He was previously executive vice-president of the Lexington Motor Co., Connersville, Ind.

Frank B. Hanford has accepted a position as sales engineer for the Simplex Air Brake Sales Corporation, New York City.

C. O. Harmon, who was formerly associated with the Cleveland Experimental Laboratories Co., Cleveland, has been made general manager of the Weger Marine Engine Co., also of Cleveland.

Daniel F. Harriman has severed his connection with the Crane-Simplex Co., Long Island City, N. Y., where he was chief engineer. No announcement has been made of his future plans.

R. M. Hazen, who was formerly connected with the dynamics research section of the General Motors Research Corporation, Dayton, Ohio, is now an instructor in mechanical engineering at the University of Minnesota, Minneapolis.

Charles E. Henderson is doing industrial engineering work with the Sherman Service, Inc., St. Louis. He was formerly engaged in purchasing supplies for the Air Mail Service, Maywood, Ill.

T. A. Henshaw, who was formerly engineer for the Wolverine Trailer Equipment Co., Detroit, has become affiliated with the Maxwell Motor Corporation, also of Detroit.

Fred A. Hoyt has severed his connection with the Simms Magneto Co., East Orange, N. J., where he was research engineer. His plans for the future have not been announced.

William H. Hubner has accepted a position as test engineer in the testing division of the Chevrolet Motor Co., Detroit. He formerly attended the University of Michigan, Ann Arbor.

John H. R. Jackson, who was until recently mechanical draftsman for the Southern Gem Mining Corporation, Pinckneyville, Ill., has joined the engineering department of the signal engineers of the Illinois Central Railroad, Chicago.

Fred H. Junk has become associated with the McClelland-Gentry Motor Co., Oklahoma City, Okla. He was formerly service representative for the Hudson Motor Car Co., Detroit.

A. R. Keagy is now connected with the Michigan Body Corporation, St. Johns, Mich. He was previously consulting sales engineer and State representative for the Ruggles Motor Truck Co., Saginaw, Mich.

(*Continued on p. 6*)

PERSONAL NOTES OF THE MEMBERS

Continued

B. F. Kelly has been made vice-president of the Parts Corporation, Indianapolis. As announced in the September number of THE JOURNAL, he was formerly director of sales and advertising for the Weidely Motors Co., also of Indianapolis.

H. E. Lambert has been appointed production manager of the Toygro Co., Chicago. He was previously chief engineer for the Claybourn Process Corporation, Milwaukee.

C. H. Landsittel, who was formerly purchasing manager for the Fox Motor Car Co., Philadelphia, Pa., is now associated with the Stutz Motor Co., Cleveland.

Charles L. Lawrance, president and chief engineer of the Lawrance Aero-Engine Corporation, New York City, has severed his connection with that organization, and has been made vice-president of the Wright Aeronautical Corporation, Paterson, N. J.

A. W. Lieberman has severed his connection with the Tandem Drive Car Co., Akron, Ohio. No announcement has been made of his future plans.

Joseph C. Linn, who was formerly chief engineer for the Ansted Engineering Co., Connersville, Ind., has been made engineer in charge of machine design for the Indiana Piston Ring Co., Hagerstown, Ind.

Raymond L. McFarland is now associated with the Wappelo Battery & Electric Co., Ottumwa, Iowa. He was formerly assistant professor and head of the automotive department at the Iowa State College, Ames.

A. G. McLerie is no longer flying officer in charge of armament for the Canadian Air Force, Camp Borden, Ont., but has become associated with the Fairchild Aerial Surveys, Ltd., Grand Mere, P. O., Canada.

William C. Marshall, who, as announced in the September number of THE JOURNAL, was formerly mechanical engineer for the Trexler Co. of America, Wilmington, Del., is now mechanical and maintenance engineer, including the management of the plant, for Richard Hellmann, Inc., Long Island City, N. Y.

Hemsley B. Massey has accepted a position with the Electrical Development & Machine Co., Philadelphia. He was formerly chief engineer for the Holmes Automobile Co., Canton, Ohio.

M. I. Mathewson, who was previously research engineer for the Detroit Gear & Machinery Co., Detroit, has become grinding machine engineer for the Brown & Sharpe Mfg. Co., Providence, R. I.

George B. Mitchell is no longer special representative for the Wyckoff Drawn Steel Co., Pittsburgh, but has been appointed sales manager for the Union Drawn Steel Co., Beaver Falls, Pa.

R. J. Murphy has resigned as president in full charge of retail sales of the District Oakland Co., City of Washington. His future plans have not been announced.

Frederick D. Norman has been made chief inspector for the Belden Mfg. Co., Chicago.

Gust Olson, Jr., has been made sales engineer for the Yellow Sleeve-Valve Engine Works, Inc., East Moline, Ill. He was previously chief engineer for the R & V Motor Co., also of East Moline.

Joseph F. Owens, who was formerly sales manager for the Lapointe Machine Tool Co., Hudson, Mass., has been made vice-president and will assume the duties of the manager of the Syracuse office of Crane-Schiefer-Owens, Inc.

Humphrey F. Parker has been made assistant physicist at the Aeronautical Engine Laboratory, City of Washington.

W. D. Reese, formerly engineer for the Yellow Coach Mfg. Co., Chicago, is now associated with the Yellow Sleeve-Valve Engine Works, Inc., East Moline, Ill.

Louis L. Roberts has been made assistant mechanical superintendent of the Packard Motor Car Co., Detroit.

(*Concluded on p.* 8)

PERSONAL NOTES OF THE MEMBERS

Concluded

I. D. Rocap has become salesman for the District Oakland Co., City of Washington.

William C. Rosenthal, who formerly acted as manufacturers' agent in Chicago, has become associated with the Yellow Cab Mfg. Co., also of Chicago.

George S. Salzman is no longer treasurer and factory manager for the Grant Motor Car Corporation, Cleveland, but has been made general manager of the Monmouth Machine Co., also of Cleveland.

Harold W. Scholl has been appointed sales manager of the Splitdorf Electrical Co. of New England, Boston.

Charles M. Schwab has resigned his position as production engineer with the Electric Service Supplies Co., Philadelphia. No announcement has been made of his future plans.

Charles S. Trask, who was formerly superintendent and engineer for the Electric Machine Corporation, Indianapolis, has been appointed plant efficiency engineer for the Rockwood Mfg. Co., also of Indianapolis.

Joseph R. Warner, until recently chief draftsman for the Dyneto Electric Co., Syracuse, N. Y., has joined the engineering department of the Galion Iron Works & Mfg. Co., Galion, Ohio.

Glenn Weller has accepted a position as assistant chief engineer in the open-hearth, bar mill and sheet mills of the Mansfield Sheet & Tin Plate Co., Mansfield, Ohio. He was formerly doing engineering work for the Westinghouse Electric Products Co., also of Mansfield.

G. M. Williams, for 5 years general manager of the Dayton-Wright Airplane Co., Dayton, Ohio, was elected president of the Wire Wheel Corporation of America, at a recent meeting of the board of directors in New York City.

Zakar A. Yeram, who was formerly affiliated with the American Motor Truck Co., Newark, Ohio, has become designing checker in the design department of the Jeffrey Mfg. Co., Columbus, Ohio.

Notes and Reviews

In this column are given brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

APPARATUS USED IN HIGHWAY RESEARCH PROJECTS IN THE UNITED STATES. By C. A. Hogentogler. *National Research Council Bulletin No.* 35, August, 1923. 91 pp.; 70 illustrations.

The purpose of this report is to assist in establishing a fund of common knowledge on the part of investigators of similar problems, by describing the principle and construction of each device and the use for which it was designed. The information was obtained through the sending of questionnaires to investigators in this country interested in highway research projects.

REPORT OF HIGHWAY RESEARCH AT PITTSBURG, CAL., 1921-1922. Published by California State Printing Office, Sacramento, Cal. 146 pp.; 120 illustrations; 17 tables.

A presentation of the methods employed and results obtained at the Pittsburg, Cal., test highway.

CROSS-COUNTRY CARGO TRANSPORTATION. By A. B. Quinton, Jr. Published in *Army Ordnance*, July-August, 1923, p. 3.

Presents a summary of the work done by the Ordnance Department during the past 4 years with a view to furnishing cargo-carrying vehicles of an improved type, with especial reference to their use over poor roads and across country.

MILITARY MOTOR TRANSPORTATION. Prepared at the Coast Artillery School by direction of the Chief of Coast Artillery. Published by *The Coast Artillery Journal*, Fortress Monroe, Va. 414 pp.; 320 illustrations.

Intended primarily for use as a textbook in the motor transportation course at The Coast Artillery School, this book covers in general the fundamental principles of motor-vehicle construction and operation and in particular the construction, care and operation of standard Army motor transportation assigned to the Coast Artillery Corps.

USE OF STEEL BY THE AUTOMOBILE INDUSTRIES. By A. H. Chamberlain. Published in *The Automotive Manufacturer*, July, 1923, p. 15.

A paper presented before convention of American Iron, Steel and Heavy Hardware Association at Chicago, May 15, 1923.

ENDURANCE OF STEEL IN TENSION, TORSION AND IMPACT. By D. J. McAdam. Published in *Engineering News-Record*, Aug. 23, 1923, p. 298. 5 illustrations; 1 table.

Abstract of a paper presented at the annual meeting of the American Society for Testing Materials, showing that endurance under three kinds of stressing is of the same general kind, though numerical values differ.

ENDURANCE OF STEEL: SECOND ILLINOIS REPORT. Published in *Engineering News-Record*, Aug. 23, 1923, p. 308. 6 illustrations.

Discussion of tests reported by H. F. Moore and T. M. Jasper in the University of Illinois Engineering Experiment Station Bulletin No. 136.

A STUDY OF THE STEELS USED FOR PISTON-PINS. By S. P. Rockwell. Published in *Motor Age*, Aug. 16, 1923, p. 23.

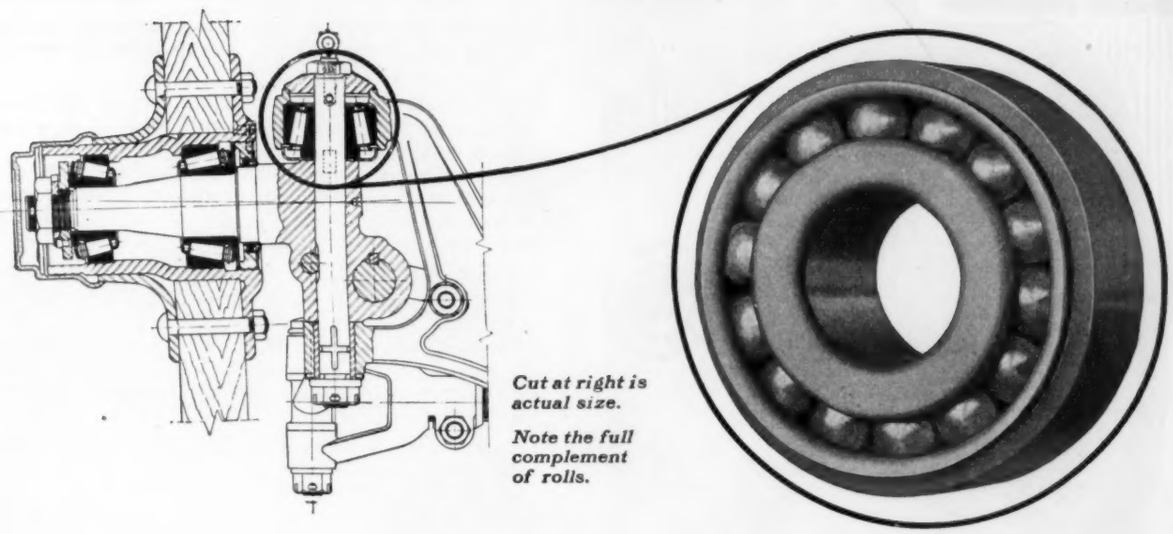
A brief discussion of the characteristics and specifications of the various alloys, with special reference to wearing qualities.

CHARACTERISTIC PROPERTIES OF DURALUMIN. By Horace C. Knerr. Published in *Forging-Stamping-Heat Treating*, August, 1923, p. 332. Illustrated.

Revised abstract of paper presented at the convention of the American Society for Steel Treating, Detroit, Oct. 6, 1922.

THE FATIGUE LIMIT AND PROPORTIONALITY OF MONEL METAL. Published in *Engineering*, July 20, 1923, p. 88.

(*Continued on p.* 12)



Cut at right is actual size.

Note the full complement of rolls.

A Special Taper Roller Bearing Designed for Steering Pivots

The difficulty with steering pivot bearings has been the excessive wear due to the rotating movement being confined to the narrow limit of the steering angle. This with the additional wear of constant road shocks has resulted in rapid wearing of grooves in the paths of the rollers.

The bearing here illustrated has been designed to meet this condition and after successful trial has been adopted for use in some of America's finest cars.

It contains a full complement of rolls, (round on the end, an exclusive Bock feature,) fourteen in number, of such a size and so close together that in the average turning angle the paths of the rolls overlap. This distributes the steering wear over the entire bearing cone instead of localizing it and causing excessive wear.

It also provides more load carrying surface for the constant hammer of road shocks.

The result is *easier steering*, and *much longer life.* Let us submit samples for testing.

THE BOCK BEARING COMPANY, *Toledo, Ohio*

—BOCK—

Quality TAPER ROLLER BEARINGS

NOTES AND REVIEWS

Continued

RAIL-CAR DESIGN CHANGES ARE SUGGESTED AS RESULT OF OPERATING EXPERIENCES. Published in *Automotive Industries*, Aug. 9, 1923, p. 268.

BETTER CITY PLANNING NEEDED TO SOLVE SERIOUS TRAFFIC PROBLEMS. By Alvan Macauley. Published in *Automotive Industries*, Aug. 9, 1923, p. 262.

Besides pointing out the numerous difficulties involved, the author gives some suggestions for improvement and shows how the automotive industry can do its part to better conditions.

UNIFORM TRAFFIC CODE HELPS TO MAKE HIGHWAYS SAFE. Published in *Automotive Industries*, Aug. 23, 1923, pp. 382-383.

This article discusses briefly Ohio's recent adoption of a uniform traffic code covering the entire State, and points out the need for such simplification of regulation throughout the Country.

HIGHWAY DEVELOPMENT BY THE ALASKA ROAD COMMISSION. By James Gordon Steese. Published in *Engineering News-Record*, Sept. 27, 1923, pp. 506-508; 5 illustrations.

EFFECT OF CURING METHODS ON CONCRETE ROADS. By H. J. Kuelling. Published in *Engineering News-Record*, Sept. 20, 1923, pp. 466-468.

An account of tests of various methods of curing road slabs to determine the effects on wear and transverse strength.

METAL AEROPLANE CONSTRUCTION. By Hugo Junkers. Published in *The Journal of the Royal Aeronautical Society*, September, 1923, pp. 406-449; 49 illustrations.

The paper is not a description of the author's metal airplane as an ultimate and completed product, but rather a discussion of the evolution of the plane and the method of proceeding and working which brought him to the realization of some new fundamental ideas. The effort to diminish, as much as possible, parasite resistance led him to work on the principle of locating within the wing all parts giving resistance. With such a craft as he contemplated, the superior attributes of metal construction would become obvious in the most noteworthy degree.

There is a discussion of the two principles which were applied in the design of the wings of his plane, as well as a brief description of the airplane and its trial flights. Some space is devoted to a consideration of duralumin; to the two arrangements of the wings—the parasol and the low wing trim; and to the development of hydroplanes. The advantages of metal construction, it is stated, become relatively more pronounced in the larger airplane than in the small one.

STEEL STRUCTURAL PARTS FOR AIRCRAFT. By Horace C. Knerr. Published in *The Iron Age*, Sept. 27, 1923, pp. 816-820.

This article mentions the growing tendency toward the increased use of metal in aircraft, discusses the alloy steels which have been adopted, describes heat-treating processes, and states in conclusion that rejections of heat-treated structural parts, even when subject to rigid inspection and close hardness limits after treatment, may be reduced to a comparatively negligible quantity by proper precautions, which are enumerated in the summary under eleven heads.

CRANKLESS ENGINES. Published in *The Autocar*, Sept. 7, 1923, p. 419.

A description of an eight-cylinder design, applicable to the airplane and possibly also to the automobile.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE, 1923. Published by American Society of Heating and Ventilating Engineers, New York City. 400 pp.; illustrated.

The second annual edition of the Guide, providing the engineer, the architect and the contractor with useful and re-

(*Continued on p.* 14)

NOTES AND REVIEWS

Continued

liable reference data on modern heating and ventilating practice and equipment.

ELEMENTARY THERMODYNAMICS OF AUTOMOBILE ENGINES. By Erwin H. Hamilton. Published by McGraw-Hill Book Co., New York City. 287 pp.; 168 illustrations; 31 tables.

This book, the preface states, is intended for use as a textbook in colleges, universities and technical high schools, and as an advanced text in trade schools. It covers such topics as engine cooling systems, carburetion, detonation, fuels, engine testing and the future tendencies in automobile engine design.

INTERNAL COMBUSTION ENGINES. By Robert L. Streeter. Published by McGraw-Hill Book Co., New York City. 443 pp.; 265 illustrations.

A textbook on gas and oil engines for engineers and students of engineering. The present volume is a revision of the author's textbook which was published in 1915. The revision of the book was necessary, the author states, in order to make it conform more closely to the gas engine situation today.

SELF-PROPELLING FLOATING DOCKS: A NEW FIELD FOR INTERNAL-COMBUSTION ENGINES. By C. S. Darling. Published in *The Motor Ship*, September, 1923, pp. 198-199.

THE DESIGN OF CONNECTING-RODS FOR HIGH-SPEED ENGINES. By M. Platt. Published in *The Automobile Engineer*, September, 1923, pp. 279-287.

For the purposes of design, the author states, a connecting-rod may be conveniently divided into three parts, namely, the rod proper, the small end and the big end. This paper is divided into three sections, dealing with these parts in the order given; it contains 5 tables and numerous formulæ and is illustrated by 21 figures.

BRAKE DESIGN. By P. M. Heldt. Published in *Automotive Industries*.

The second, third and fourth articles of this series are as follows: Advantages of Transmission Brakes Outweigh Disadvantages, Aug. 16, 1923, pp. 322-324; Front-Wheel Brake Design Involves Two Major Problems, Aug. 23, 1923, pp. 370-373; Pressure Is More Evenly Distributed Over Surface of Band Brakes, Aug. 30, 1923, pp. 424-426.

QUALITY OF BRAKES HAS MARKED EFFECT ON CAPACITY OF HIGHWAYS. By W. S. James. Published in *Automotive Industries*, Aug. 30, 1923, pp. 412-414.

THE ELEMENTS OF PRODUCTION GRINDING. By Ellsworth Sheldon. Published in *American Machinist*, Sept. 6, 1923, p. 373.

This, the fifth article of the series, deals with the cause and remedy of chattering.

FUEL OIL AND VISCOSITY. By M. G. Langham. Published in *Power*, Sept. 11, 1923, pp. 423-424.

The author states his belief that if all engineers interested in the efficient handling of fuel oil were to give closer attention to its viscosity, a great deal could be done to decrease the annual waste of fuel oil, and at the same time improve the conditions of combustion and eliminate many of the troubles caused by incomplete combustion.

REMARKABLE STRIDES MADE IN PRODUCTION OF LIQUID FUELS FROM COAL. Published in *Automotive Industries*, Aug. 30, 1923, pp. 432-435.

DILUTION OF CRANKCASE OIL IS SERIOUS FACTOR EVEN IN SUMMER. By A. Ludlow Clayden. Published in *Automotive Industries*, Aug. 30, 1923, pp. 415-417.

FRONT AXLE DESIGN. Published in *The Autocar*, Sept. 14, 1923, pp. 450-452.

After mentioning the likelihood that front axle design will come into prominence during the next few months on account

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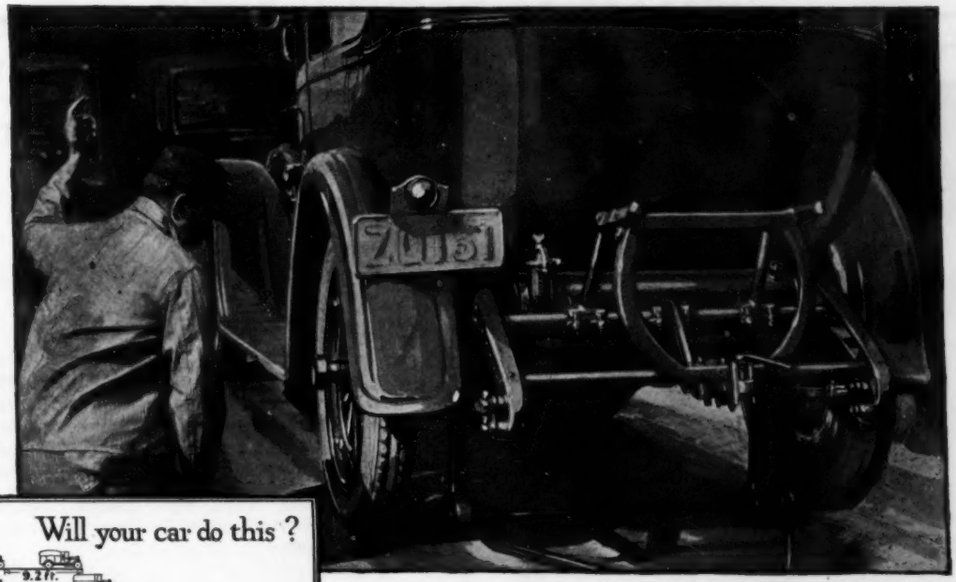
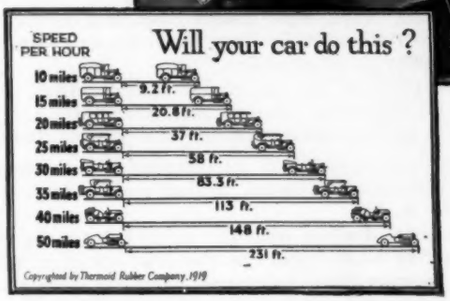


Famous Thermoid Stopping Chart—shows distances in which car should stop if brakes are efficient. Brakes lined with Thermoid meet these standards.



Brake bands equally spaced

but one wheel always stops first

A test which proves the value of Thermoid as a sure, "quick" brake lining

Jack up the rear—put an ordinary soft lining on one band, Thermoid Hydraulic Compressed Lining on the other. Space the adjustments equally, let 'er spin, and put on the brakes.

The wheel braked by Thermoid *stops first.*

Now adjust the ordinary brake lining closer, and repeat the test. Even after *several* adjustments Thermoid will still stop its wheel first.

Thermoid Brake Lining grips like this because all further "give" is compressed out under 2000 pounds hydraulic pressure! This makes Thermoid so dense, so compact, that it grips from the first day on.

We take the "give" out of Thermoid in the factory—in its place we put *40% more material.* That's why Thermoid is last to show the "ragged edge" between drum and brake band.

Left: steady wear soon squeezes out "ragged edge" on ordinary soft brake lining. This means poor wear and frequent adjustment. Right: Thermoid Hydraulic Compressed Lining is too compact to squeeze out. Wears down slowly, grips when worn wafer-thin. Needs fewer adjustments.

Amazing tests show resistance to moisture

Recent laboratory experiments show Thermoid's astonishing ability to resist moisture. Soaked in water for an hour, ordinary brake lining was found to absorb 164% more water than Thermoid—in boiling oil, 290% more than Thermoid—in gasoline, 194% more than Thermoid.

Send for our booklet, "The Dangers of Faulty Brakes." It contains valuable information and complete records of brake lining tests which every engineer will be glad to have on hand.

THERMOID RUBBER COMPANY

Factory and Main Offices: Trenton, N. J.

New York Chicago Los Angeles Detroit Atlanta San Francisco
Boston Cleveland Kansas City Seattle London Paris Turin

Thermoid Brake Lining

Hydraulic Compressed

Makers of "Thermoid-Hardy Universal Joints" and "Thermoid Crolide Compound Tires"

NOTES AND REVIEWS

Continued

of the adoption of front-wheel brakes, this article discusses current practice in the layout of the front axle, the steering pivot and the stub axle, and gives pictured examples of modern front axles.

IMPROVED SUSPENSION SYSTEMS. Published in *The Motor*, Sept. 4, 1923, pp. 185-186.

INDUSTRIAL LUBRICATING OILS. By J. Levy. Published in *La Technique Moderne*, Sept. 1, 1923, pp. 522-530.

Starting with the statement that, even when a study of lubricants is limited to liquid lubricants, viscosity is not the only factor to be considered, the article raises and discusses the question as to what in a general way are the different properties essential for a liquid lubricant.

EXPERIMENTS WITH THE JARAY-STREAMLINE CAR. By R. Conrad. Published in *Der Motorwagen*, Aug. 31, 1923, pp. 355-363; 10 illustrations.

A description of the car under consideration, the general and special aspects of the test, the procedure, a criticism of the results and a summary of the author's conclusions.

DRILLING PROPERTIES VARY IN BRASSES AND BRONZES. By J. F. Hardecker. Published in *Automotive Industries*, Aug. 30, 1923, p. 423.

This article, dealing with the subject from the standpoint of automotive work, gives the chemical compositions and the drilling qualities of the following: extruded aluminum bronze, red brass, phosphor bronze, naval brass, high copper phosphor bronze, special phosphor bronze, manganese bronze, free-cutting brass, and special naval brass.

CAUSE OF RED HARDNESS OF HIGH-SPEED STEEL. By Edgar C. Bain and Dr. Zay Jeffries. Published in *The Iron Age*, Sept. 27, 1923, pp. 805-810.

Facts are enumerated on which the authors base certain conclusions regarding the changes taking place in high-speed steel with various heat treatments.

POURING AND FITTING BABBITT LININGS. By A. Hoyt Levy. Published in *Power*, Sept. 25, 1923, pp. 484-487.

This article tells of the nature of babbitt metals, how to renew linings, and describes some bearing troubles as well as their cause.

RUBBER LATEX. By C. C. Loomis and H. E. Stump. Published in *Chemical and Metallurgical Engineering*, Sept. 17, 1923, pp. 540-542.

Some of the problems and interesting phenomena that occur in adding compounding ingredients to rubber latex are discussed and analyzed.

"COMFORT" TIRES UNDER TEST. By W. F. Bradley. Published in *The Autocar*, Sept. 7, 1923, pp. 409-410.

A brief account of European tests of balloon tires.

INFINITELY VARIABLE GEARS. Published in *The Motor*, Sept. 4, 1923, pp. 172-173.

An illustrated description of two designs which attempt to provide an infinite number of graduated speed ratios in place of the limited number of steps commonly used.

NEW BEVEL-GEAR GENERATOR. Published in *The Iron Age*, Sept. 27, 1923, p. 850. Also, in *American Machinist*, Sept. 27, 1923, pp. 490-491.

Description of a new bevel-gear generator for producing high-grade bevel-gears on a mass production basis.

GEAR-CHANGING MADE EASY. Published in *The Autocar*, Sept. 7, 1923, pp. 411-412.

An illustrated description of a device with which, it is claimed, it is impossible to make a bad gear change at any speed.

SELF-CONTAINED KEROSENE CARBURETER DEVELOPED IN ENGLAND. Published in *Automotive Industries*, Aug. 30, 1923, pp. 436-437.

Good Driving Is Mostly

NICE STEERING

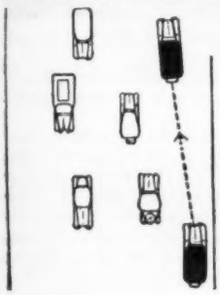
HOW TO PARK—HOW TO DRIVE—HOW TO ENJOY YOUR MOTOR CAR MORE

THIS ARTICLE (Continued on next 2 pages) SHOULD BE KEPT FOR REFERENCE

THE suggestions for the driving of motor cars and motor trucks presented here are not intended to be absolute or final. It is understood that exigencies arise around which no rules can be laid; on the other hand, the applications of the few simple principles outlined here, in ordinary driving, will better fit the driver to meet the emergency situations as they arise.

ATTENTION TO THE JOB IN HAND is first and most important. The good driver is never careless.

TREATING YOUR GUEST IN YOUR CAR AS YOU WOULD IN YOUR HOME is the first point of driving etiquette. It is not only discourteous, but illegal, to risk lives.



In interpreting some of the instructions and suggestions the divergence of State Laws must be considered.

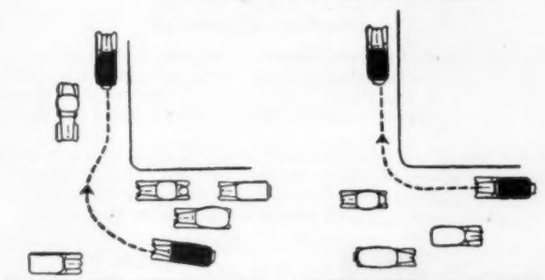
City Driving

Avoid sharp turns, either to right or left.

When moving out from curb, do so in a gradual, diagonal line. When swinging in to curb, do so slowly and gradually.

Tell the driver behind as much as possible by the use of left-arm signals.

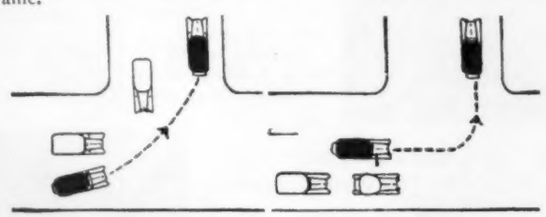
Do not depend upon his following your instructions. Your signal does not give you the right to turn in front of him.



Incorrect method of turning right *Correct method of turning right*

When turning to right at street intersections get as close to right curb as possible before turning.

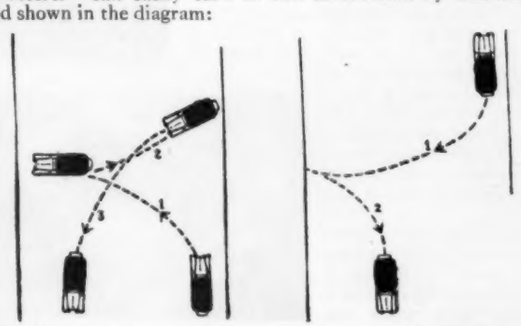
When turning to left at street intersection get into extreme left lane of traffic.



Incorrect method of turning left *Correct method of turning left*

When approaching a street intersection, the "Nice-Steerer" slows down to a speed from which he can stop quickly.

In turning around in a street where there is much traffic three movements are necessary. In streets where there is little or no traffic, the "Nice-Steerer" can easily turn in two movements by following the method shown in the diagram:



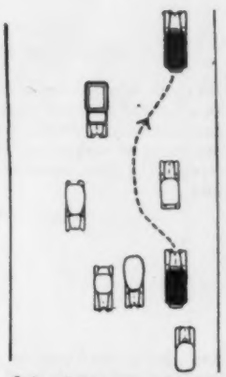
Turning around in three movements *Turning around in two movements*

The "Nice-Steerer" never cuts in quickly after passing another machine. He realizes that the other car is moving also, and he allows ample time before gradually getting back to his place on the right of the road.

The traffic lanes near the center of the street are for "through" traffic; that is, cars that are not contemplating turning off to the right at the next several streets. The right-hand lanes are for slow, or parking, or right-turning traffic.

The "Nice-Steerer" remembers that the rear wheels do not "track" the front wheels in turning. He allows ample, but not too much, leeway for the rear wheels to miss curbs, posts, guards, traffic signals, building corners, etc.

As a rule it will be found a time and trouble saver to "turn about" by driving around the block rather than jamming traffic by turning in the street. (This is not allowed, anyway, in many communities.)



It is safest to turn out to pass immediately after a car has gone by in the other direction. Then you are sure no one behind is passing you.

Another opportunity for "Nice-Steering" presents itself minutely in avoiding bumps, ruts, track-crossings, etc. The steering wheel should not be moved too quickly; the reaction is difficult to compensate for; and it imperils all neighboring cars. So long as both front wheels, or both rear wheels, do not hit the obstacle at the same time, the results are not bad.

Street car tracks are at all times, but particularly in wet weather, dangerous to negotiate. If the "Nice-Steerer" finds himself in the tracks he flips his wheels first to one side, then quickly to the other, and thereby scrapes the tires as little as possible, while maintaining complete control of the vehicle.

Wet Streets

On wet streets the careful driver is even more careful.

Skidding, once started, is hard to stop. Turning the wheels in the direction of the skid will help. But this is dangerous inasmuch as usually there are cars, or children, or curbs, in the way.

THE ONLY SKID THAT YOU CAN CONTROL ABSOLUTELY IS THE ONE THAT DOESN'T START!

(Continued on Page 32

GOOD DRIVING IS MOSTLY NICE STEERING — (Continued from Page 31

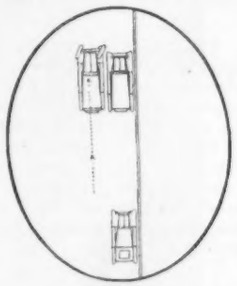
Slow, even turns; slow, even stops; slow, even starts will avoid skids.

Do not disengage your clutch!

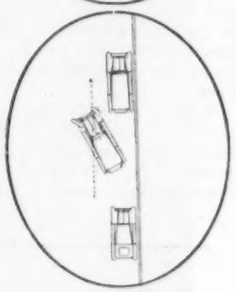
Tire chains are of assistance on wet or muddy roads.

Clear vision, obtained by windshield wipers, is also essential.

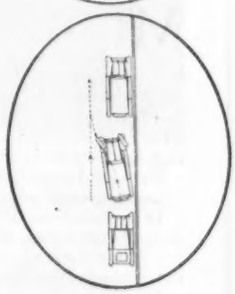
Can You Park?



An easily learned method of proper parking in a limited space is to stop parallel to the curb alongside of the car behind which you are going to park, about one foot outside of it; turn the front wheels sharply to the curb and



back slowly until you can see that by swinging the front wheels hard over to the left, your right front fender will just clear the left rear fender of car ahead; turn wheels fully to the left and



back to proper position at curb. This method, once you know positions at which extreme turns are to be made, will park you at the proper distance from curb and other cars in one backward movement.

Country Driving

While the "Nice-Steerer" keeps constantly on the alert even while driving through little-trafficked roads, the first thing to be learned for comfortable touring or long-distance driving is a safe method of relaxation.

Authorities agree that the safest and sanest grip on the wheel is one hand above the other one palm up, the other down. (See illustration.) This grip provides the greatest leverage on the wheel with the least exertion. And all of the necessary exponents of safe driving—hand brake, horn, throttle, etc., are within easy reach.

The intermittent use of the hand throttle, on good, open roads, will rest the right foot and leg. The occasional use of the hand brake, besides being an excellent method of conserving both brakes, is also expedient and safe.

At no time should both hands be free of the wheel. Small stones, ruts, and bumps will quickly disturb the equilibrium and throw the car in the ditch.

Do not stop (to repair tires, etc.) in the middle of the road, near curves, or near the crest of hills.

Stones should be removed from the road after using them to block the wheels.

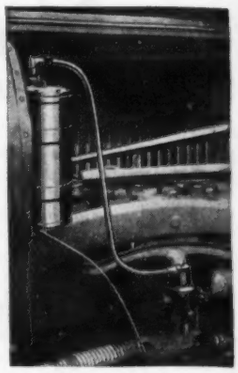
Starting the Motor

The spark should be retarded.

The clutch should be disengaged so that the battery need not uselessly turn over the transmission gears.

It is often easier to start the motor by turning it over several times, with the air choked, before turning on the switch.

Gasoline Line and Carburetor



Dirt in the gasoline line—and there will be dirt despite the most careful filling—should be forced out by air.

Dirt or water in the vacuum tank may be removed through the cap-screw at the bottom.

Dirt or water in the float chamber of the carburetor may be cleaned out by removing the screen container and blowing out both the container and screen.

The petcock at the bottom of the carburetor should be opened frequently to permit the accumulated water to run out.

Cooling System

Keep the radiator well filled. Use soft water, if you can get it.

The radiator should be completely drained and flushed at intervals of about once a month.

The fan belt should be tight to prevent slipping, but not too tight for easy running.

In the mounting of the fan, Timken Tapered Roller Bearings assure the same attentionless service that they give in the more severe service points of the motor vehicle. For lubrication of fan see general lubrication chart in this article.

Steering Apparatus

The steering apparatus requires little attention, but should be inspected frequently to make sure that the front wheels are in line and that there is no play in either the wheels, the tie-rod, or remainder of the gearing.

Tires should be kept properly inflated. (See table of tire pressures in this article.)

And above all, the best assurance of easy steering is to own a machine, the steering pivots of which are mounted on Timken Tapered Roller Bearings. In such machines the steering mechanisms—instead of scraping and grinding—turn easily on the rollers of Timken Bearings.

Battery

At least once in two weeks, and oftener in hot weather, the battery should be inspected to see that distilled water covers the plates in each cell by ½ inch.

If the hydrometer shows a reading of less than 1250, the battery should be recharged. A reading of 1280 means that the battery is fully charged.

Dry the top of the battery after filling. Keep terminals clean. An application of vaseline aids in preventing corrosion.

Spark Plugs

Clean, heavy-hitting spark plugs delight the "Nice-Steerer."

Plugs can best be cleaned by soaking in kerosene and scraping with a dull knife.

The points of the spark plug should be set apart about the thickness of a worn dime.

Lights

Both head and tail lights should be inspected before starting out.

It is a good plan to carry an extra headlight bulb, tail-light bulb, and fuse, for lights may burn out any time.

To avoid danger to yourself, as well as other machines, your lights should be focused so that they do not throw their rays above four feet from the ground at any point.

The "Nice-Steerer" uses his dimmers when meeting other machines, for many lenses that are legal throw a blinding glare when the bright lights are on.

(Continued on Page 33


KERITE
A product of over fifty years distinguished service in the most important electrical fields, possessing inherent characteristics which make it pre-eminently desirable for High Tension Automotive Ignition
DAYS KERITE
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KERITE INSULATED WIRE & CABLE COMPANY

Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

Paul C. Ackerman has accepted a position as draftsman of the Doble Steam Motors Corporation, San Francisco. Previous to this connection he attended the Michigan State Auto School, Detroit.

George B. Allen, who until recently was chief engineer for the Liberty Motor Car Co., Detroit, is now connected with the engineering department of Dodge Bros., also of Detroit.

John H. Allen has been made general manager of the Eisemann Magneto Corporation, Brooklyn, N. Y., succeeding Charles Ethan Davis, resigned. Mr. Allen has been associated with the Eisemann organization for several years in the capacity of works manager and assistant general manager.

J. S. Anderson, who was formerly chief engineer for the Phelps Light & Power Co., Rock Island, Ill., has become affiliated with the Checker Cab Mfg. Corporation, Kalamazoo, Mich.

A. Caryl Bigelow is no longer president and general manager of the United Motor Car Co., Trenton, N. J., but has been made vice-president and general manager of the Wills Sainte Claire Co. of New York, New York City.

George C. Brainard has become affiliated with the General Fireproofing Co., Youngstown, Ohio. Previous to this he was vice-president of the Hydraulic Steel Co., Cleveland.

W. J. Bryan resigned recently from the Budd Wheel Co., Philadelphia, where he was sales manager for the last 4 years, to become associated in a similar capacity with the Detroit office of the Heintz Mfg. Co., also of Philadelphia.

Walter P. Burn has been appointed Pacific coast manager for the Outdoor Advertising Agency of America, New York City. His previous business connection was with the Transcontinental Oil Co., Pittsburgh, as sales promotion and advertising manager.

Henri G. Chatain, who was formerly engineer in connection with gas-electric motor cars for the General Electric Co., Erie, Pa., is now affiliated with the engineering department of the Hammermill Paper Co., also of Erie.

Reginald Clark recently became associated with the Spicer Mfg. Co., Plainfield, N. J. He was prior to that time factory manager for the Western Drop Forge Co., Marion, Ind.

Harry L. Coffey has accepted a position with the American Motors Corporation, Plainfield, N. J.

H. C. Colburn has become chief engineer of the Colburn Radio Laboratories, San Leandro, Cal. He was formerly radio engineer for the Magnavox Co., Oakland, Cal.

(*Continued on p.* 4)

PERSONAL NOTES OF THE MEMBERS

Continued

Lewis H. Davis has been appointed chief inspector for the Stutz Motor Car Co., Inc., Indianapolis. Until recently he attended Purdue University, Lafayette, Ind.

Edward Dixon, who was formerly chief engineer for the Checker Cab Mfg. Co., Chicago, has been elected president of the Big 4 Auto Co., also of Chicago.

O. M. Donaldson, who for a number of years was Cleveland district manager for the Briggs & Stratton Co., Milwaukee, and since October, 1922 was in charge of motor sales for the Allis-Chalmers Mfg. Co., Chicago, has been appointed director of manufacturers sales for Outlook, Cleveland.

Albert H. Doolittle has become affiliated with the Philbrin Corporation, Kennett Square, Pa., as sales manager.

Clarence A. Earl has been made president of National Motors, Inc., Chicago.

George F. Fisher has accepted a position with the Continental Mexican Rubber Co., New York City.

G. E. Franquist has severed his connection as chief engineer for James Cunningham, Son & Co., Rochester, N. Y. His plans for the future have not been announced.

L. O. Haskins, who was formerly president of the Water Baby Mfg. Co., Detroit, has been appointed director of sales of the Ohio Trent Coal, Coke & Amalgam Co., Toledo.

Fred A. Hoyt has accepted a position as engineer for the Western Electric Co., New York City.

Major Mark L. Ireland has been assigned to the 79th Division, Organized Reserves, at Schuyllkill Arsenal, Philadelphia. Previous to this he was detailed for 2 years at the Massachusetts Institute of Technology, Cambridge, and for 1 year at the University of Michigan, Ann Arbor, to study the interrelationship of highway, railway and waterway transport.

C. M. Johnson has accepted a position as salesman for the Washington Hardware Co., Tacoma, Wash.

I. L. Johnson, who was formerly machinist for the Minneapolis Steel & Machinery Co., Minneapolis, is now affiliated with Fairbanks, Morse & Co., St. Paul, Minn.

Hugh I. Jones has severed his connection with the Willys Morrow Co., Elmira, N. Y., where he was assistant metallurgist. His plans for the future have not been announced.

Alexander W. Keller has become associated with Edward Smith & Co., Long Island City, N. Y.

E. W. Kelley, who was previously draftsman for the Fulton Iron Works, St. Louis, has accepted a position with the Weaver Mfg. Co., Springfield, Ill.

Albert E. Koeckert, who was until recently manager for the Phoenix Engineering Co., Cleveland, is now associated with the Mechanical Rubber Co., also of Cleveland.

Roland M. Kohr has been made chemist for the Grasselli Chemical Co., Clarksburg, W. Va. Previous to this he held a similar position with the National Refining Co., Findlay, Ohio.

Henry Krebs, who was formerly in the turbine drafting department of the General Electric Co., Lynn, Mass., has joined the engineering department of the Packard Motor Car Co., Detroit.

(*Continued on p. 6*)

SRB Bearings in Packard Motor Cars are located as follows:

Single-Six
Clutch throwout
Transmission mainshaft rear
Rear axle wheels

Single-Eight
Clutch throwout
Transmission mainshaft rear
Rear wheels
Steering column

The striking thing about the Single-Eight is that it does the things which are vital, in a more positive, effective way, than they have ever been done before.

...king contributions to ...other motoring, ...ements, but very definite qualities quickly discernible.

It is not just a generalization but a fact, that in comfort, acceleration, flexibility, brake-action, steering and ease of control, the Single-Eight has gone far beyond previous practice.

The instant and enthusiastic acceptance of these facts renders it certain that the Single-Eight will dominate its own particular field just as unmistakably as does its companion car — the Packard Single-Six.

...ine Distinguished Body Types, Open and Enclosed, at Prices Ranging from $3550 to $4900—at Detroit
Packard Single-Six Furnished in Eleven Popular Body Types, Open and Enclosed

SRB

THE Packard Motor Car Company has long relied upon this Organization as a source of supply for Annular Ball Bearings, as have a majority of the larger independent automobile, truck and tractor manufacturers.

SRB Annular Ball Bearings have built up an enviable reputation for accurate workmanship—long life—correct design—and quiet frictionless operation and are, therefore, a logical part of the mechanism of the finer types of American automotive manufacture.

STANDARD STEEL AND BEARINGS INCORPORATED

PLAINVILLE CONNECTICUT

SRB Bearings are serviced by the branches of the Standard Sales and Service Co., throughout the United States

PERSONAL NOTES OF THE MEMBERS

Continued

Joseph B. Lindecker has severed his connection with the Willys-Overland Co., Toledo, where he was layout draftsman in charge of the patent drafting department. No announcement has been made of his future plans.

Frank J. Lucas, who until recently was chief engineer for the Hamilton Beach Mfg. Co., Racine, Wis., has become mechanical engineer in charge of methods development at the Hawthorne Works of the Western Electric Co., Cicero, Ill.

E. T. Mathewson resigned on Nov. 1 as district manager of the S K F Industries, Inc., Buffalo, to devote his entire time to the development of the products of the Nichols & Wright Motor Co., Buffalo, of which he has been president for the past 5 years.

A. H. Midgley, who was formerly technical director of Scholey & Co., Ltd., London, S. W., England, has organized the Midgley Car Lighting Co., Ltd., also in London.

Clifford A. Miller has accepted a position as assistant chief draftsman in the engineering department of the White Motor Co., Cleveland. He was previously engineer and designer for Weaver & Kemble, also of Cleveland.

G. Reynolds Miller has severed his connection with the Daniels Motor Co., Reading, Pa., where he was general purchasing agent. His plans for the future have not been announced.

Robert I. Miner, who was previously tool engineer for the Cadillac Motor Car Co., Detroit, has been made assistant chief engineer for the Bossert Corporation, Utica, N. Y.

Herbert N. Nigg has been appointed general manager of the Frost Gear & Forge Co., Jackson, Mich. He was formerly vice-president and general manager of the Detroit Bevel Gear Co., Detroit.

John W. Peterson has severed his connection as factory manager in the wheel division of the Detroit Pressed Steel Co., Detroit. His plans for the future have not been announced.

A. G. Prosperi, who was formerly president of the Oakland Sales Co., Tampa, Fla., has become associated with Harvey Ringler Motor Sales, Philadelphia.

P. W. Rhame has been made superintendent of inspection for the A. C. Spark Plug Co., Flint, Mich. He was until recently instructor in the University of Minnesota, Minneapolis.

Walter C. Robbins, who was formerly connected in an engineering capacity with the Stevens-Duryea Co., Chicopee Falls, Mass., and was also chief engineer for the Curtiss Aeroplane Co., Buffalo, has been appointed general manager of the International Metal Hose Co., Inc., Cleveland.

O. J. Rohde has been appointed general manager of the Torrington Co. of Delaware, New York City. His previous business connection was with the Wire Wheel Co. of America, Detroit, in a similar capacity.

Paul H. Schweitzer is now automotive designer for the Yellow Coach Mfg. Co., Chicago. Prior to this he was mechanical engineer and tool designer for the Oakland Motor Car Co., Pontiac, Mich.

Ralph H. Sherry, formerly metallurgical engineer for General Motors Corporation, and later for the Willys Corporation, Elizabeth, N. J., has become associated with the International Harvester Co., Chicago, as chief metallurgist.

(*Concluded on p.* 8)

PERSONAL NOTES OF THE MEMBERS

Concluded

George W. Sower has joined the engineering department of the Jeffrey Mfg. Co., Columbus, Ohio. He was, until recently, draftsman in connection with aircraft and power-plant design and installation for the Glenn L. Martin Co., Cleveland.

Horace N. Stevenson, who was previously assistant experimental engineer for the Mercer Motors Co., Trenton, N. J., has accepted a position as salesman for the Norman P. Druck Motor Co., also of Trenton.

Frank E. Storey has become chassis designer and layout man for the Hupp Motor Corporation, Detroit. He was formerly layout man for the Maxwell Motor Corporation, also of Detroit.

Foster E. Sturtevant, who was, until recently, chief inspector for the Ward Motor Vehicle Co., Mount Vernon, N. Y., has accepted a position as mechanical engineer with the Bijur Lubricating Corporation, New York City.

Clinton L. Stutter has accepted a position as toolmaker for J. Morrison Gilmour, New York City. He was formerly machinist for the White Truck Co., Long Island City, N. Y.

John Swinscoe has been made manufacturing engineer for the Olds Motor Works, Lansing, Mich. His previous business connections were with the factory organization division central office of the General Motors Corporation, Detroit.

Raymond E. Tetens, who, until recently, was assistant chief engineer for Earl Motors, Inc., Jackson, Mich., has accepted a position as draftsman with the Reo Motor Co., Lansing, Mich.

W. R. Vogeler has become associated with the General Motors Export Co., New York City, and will act in the capacity of field representative for the Central European countries, with headquarters in Copenhagen, Denmark. He was formerly export manager in Weisbaden, Germany, for the King Motor Car Co., and general manager and secretary of the King Car Corporation, New York City.

Ewald G. Wahlborg has accepted a position as body draftsman for the Chalmers plant of the Maxwell Motor Corporation, Detroit. Previous to this he was layout designer for Zeder-Skelton-Breer Engineering Co., Newark, N. J.

R. C. Wilson has become affiliated with the Fergus Motors of America, Inc., Newark, N. J.

Chase W. Wolfe, who was formerly manager having charge of manufacturer's sales for the Federal Rubber Co., Cudahy, Wis., is now associated with the Century Rubber Works, Chicago.

Notes and Reviews

In this column are given brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

NEW SLIDING CHANGE-SPEED GEARSETS ANNOUNCED IN EUROPE. Published in *Automotive Industries*, Oct. 25, 1923, p. 830.

This is an account of two new European devices, the Lavaud automatic transmission and the Constantinesco torque converter.

The Lavaud transmission is said to abolish the ordinary change-speed mechanism, the gear-ratio being automatically changed in accordance with changes in the resistance encountered in the rear wheels. In connection with a diagram, its operation is rather fully explained, following a paragraph in which the working of the device is described thus:

> By the Lavaud transmission the continuous rotary motion of the engine crankshaft is transformed into a reciprocating motion of connecting rods whose length of stroke is automatically varied by the traction resistance in inverse proportion to that resistance. This reciprocating motion is again transformed into a continuous rotary motion by ball ratchets.

In the Constantinesco torque converter as in the Lavaud transmission, the distinctive features are infinite variability and automatic variation. The illustration from which the explanation of the Constantinesco device is made is purely diagrammatic, and its exposition is less complete than is that of the mechanism just described. The inventor, it is stated, has called attention to the fact that his gear is a mechanical equivalent of an alternating-current electric circuit containing resistance and inductance in parallel. This similarity is illustrated by two diagrams. Some comment on the new devices is appended at the end of the article.

ACCURATE MANUFACTURE OF AUTOMOBILE GEARS. By A. B. Bassoff. Published in *Machinery*, November, 1923, p. 209.

The author outlines the various steps in the manufacturing process adopted in one automobile plant in an endeavor to eliminate imperfections in automobile timing and transmission gears and describes in detail the special machines employed. Four diagrams illustrate the machines under consideration, namely, machines for gear-tooth rolling, for lapping and for testing. The gears are tested for silent running after assembling on shafts, the test consisting in applying various loads at different speeds to detect noisy operation.

GEAR MAKERS SEEK TO EXPAND INDUSTRY BY FINDING NEW USES FOR PRODUCT. By P. M. Heldt. Published in *Automotive Industries*, Nov. 1, 1923, p. 903.

This article gives an account of a recent meeting of the American Gear Manufacturers' Association. An interesting feature of the meeting was a paper outlining methods for correcting errors in milled gears. In connection with the idea that in machining gear teeth by this process a cutter which is correct for producing gears with a given number of teeth is incorrect for any other number, it was pointed out that, in practice, errors of this kind are slight and that a cutter suitable for one series of numbers can, when necessary, be used to produce gears with a different number of teeth by slightly modifying the depth of the cut. When it is desirable to provide more backlash on the gears than is present when they are cut to the theoretical depth, this result, it is claimed, may be accomplished by sinking the cutters deeper into the blank.

The Committee on Composition Gearing reported work done in an endeavor to evolve a horsepower rating for gears made of phenol condensation products, six of which are on the market. Experiments testing the strength and endurance of these six products showed fairly consistent results for four of the materials, but two fell far below the others.

(*Continued on p.* 12)

Left: Steady wear soon squeezes out "ragged edge" on ordinary soft brake lining. This means poor wear and frequent adjustments.

Right: Thermoid Hydraulic Compressed Lining is too dense and compact to squeeze out. Wears down slowly, grips when worn wafer-thin. Needs fewer adjustments.

Here's why

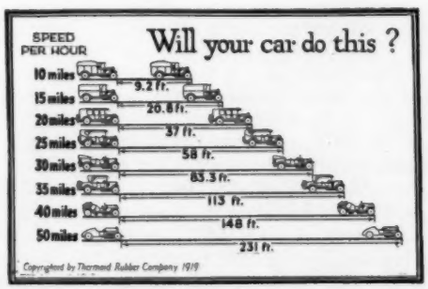
it *wears* down

slowly instead of *mashing* down quickly

Take a short strip of Thermoid Compressed Brake Lining. See how compact it is, as compared to an ordinary lining. Feel its density, its weight. This solid compactness makes Thermoid grip evenly and wear longer.

Tremendous hydraulic pressure — 2000 pounds of it — takes all further "give" out of Thermoid. In its place is compressed *40% more material* than is found in any other brake lining made.

This compression makes Thermoid *wear* down slowly instead of *mashing* down quickly.



Famous Thermoid Standard Chart—shows distances in which car should stop if brakes are efficient. Brakes lined with Thermoid meet these standards.

Thermoid doesn't "squeeze out"

The tremendous hydraulic pressure on Thermoid takes out all excess "give." That is why Thermoid is the last to show the "ragged edge" between drum and brake band.

Send for our booklet, "The Dangers of Faulty Brakes." It contains valuable information and complete records of brake lining tests which every engineer will be glad to have on hand.

THERMOID RUBBER COMPANY

Factory and Main Offices: Trenton, N. J.

New York, Chicago, Los Angeles, Detroit, Atlanta, San Francisco, Boston, Cleveland, Kansas City, Seattle, London, Paris, Turin

Thermoid Brake Lining

Hydraulic Compressed

Makers of "Thermoid-Hardy Universal Joints" and "Thermoid Crolide Compound Tires"

NOTES AND REVIEWS

Continued

In the discussion of the report of the Tooth Form Committee, it was brought out that flats on the tooth faces of hobbed gears could be considerably reduced by increasing the number of teeth in the hob.

In the report of the Differential Committee, drawings were presented of a four-pinion differential gear that is intended as recommended practice for future design.

The Metallurgical Committee stated that cast steel requirements can be grouped under three heads, namely, castings to be case-hardened, untreated castings and heat-treated castings.

Other topics discussed at the meeting included industrial relations, training shop executives, an intensive 2-year engineering course, keyway standards, the design of hobs for cutting worm gears and uses for gears other than in the transmission of power.

LAWS OF BEARING AND DRY FRICTION SIMILAR WHEN LOADS ARE HIGH. By P. M. Heldt. Published in *Automotive Industries*, Sept. 20, 1923, p. 573.

In this, the first in a series of four articles analyzing recent developments in lubrication theory and practice, the author begins by defining "boundary lubrication," tracing the history of this theory and calling attention to the diversity of opinion regarding this theory. An oil-testing machine is described, from the operation of which static friction coefficients were derived for 11 lubricants with two different combinations of metal, mild steel on cast iron and mild steel on gun metal. The conclusion is drawn from the results that static friction varies not only with oil but also with the metal of the bearing and that "oiliness" is rather an effect produced upon the metal surface than a property of the lubricant as a liquid.

RESEARCH REVEALS LAWS OF FRICTION IN LUBRICATED BEARINGS. By P. M. Heldt. Published in *Automotive Industries*, Oct. 11, 1923, p. 735.

The second article in the series describes experiments that have been made at various times to determine the effects of surface velocity, temperature, character of material and character of lubricant on frictional loss.

OPINIONS VARY REGARDING USEFULNESS OF OIL GROOVES. By P. M. Heldt. Published in *Automotive Industries*, Oct. 18, 1923, p. 800.

Hydrodynamic principles applied to lubrication would lead to the conclusion that the best results would be obtained from grooveless bearings; this theory, however, assumes a constant oil-temperature, although observation shows that the oil rises in temperature while passing through the bearing. The function of the grooves receives consideration, in this the third paper of the series, as well as the proper form of the grooves.

LUBRICATION VALUE OF OILS IS AFFECTED BY PROPERTIES OTHER THAN VISCOSITY. By P. M. Heldt. Published in *Automotive Industries*, Oct. 25, 1923, p. 842.

This, the final article in the series of four, shows that for the same general class of lubricants and within certain limits of loading, peripheral speed and fit, the friction of a bearing is directly proportional to the viscosity of the oil used, but when lubricants of different chemical characters are considered and the above limitations are removed, this relationship no longer holds, and other properties than viscosity have a part in determining the value of a lubricant. Oiliness is defined, capillarity as a factor in lubrication is discussed and the theory of colloids receives consideration.

THE STANDARDIZATION OF COMMERCIAL VISCOMETERS. By Madison L. Sheely. Published in *Industrial and Engineering Chemistry*, November, 1923, p. 1109.

After mentioning the need for the standardization of commercial viscometers and for the expression of results in terms that can be checked in other laboratories within a reasonable limit of accuracy, the methods of calibrating instruments of the capillary outflow type are considered, together

(*Continued on p.* 14)

NOTES AND REVIEWS

Continued

with a typical calibration of the MacMichael torsional viscometer as it pertains to practical usage in the commercial laboratory. Liquids and solutions suitable for the standardization of commercial types of viscometers are briefly discussed, and non-volatile oils are in general recommended for calibrating purposes at comparatively high viscosities.

CONTROL OF AIRPLANES AT LOW SPEEDS. By Melvill Jones. Published in *The Journal of the Royal Aeronautical Society*, October, 1921, p. 473.

Calling attention to the number of accidents that have occurred because of pilot's losing control when approaching the landing ground at the minimum possible speed, the author discusses the desirability of developing some broad basis upon which airplanes, under design, can be examined for controllability, as for strength and performance. The tendencies of a stalled engine that if not checked produce the spin which often precedes a fatal accident are analyzed. The necessity is stressed for control over the orientation of the airplane during slow flying, and means of securing such control are discussed.

THE WREN LIGHT AIRPLANE. Published in *Engineering*, Oct. 26, 1923, p. 526.

A description of the Wren light airplane, accompanied by three diagrams and two photographs, includes the following statements:

> The performance figures, based on an engine output of 7 hp. which is obtained at 2600 r.p.m., are as follows:
>
> | | |
> |---|---|
> | Full Speed, m.p.h., | 50 |
> | Landing Speed, m.p.h., | 25 |
> | Climb, ft. per min., | 150 |
> | Ceiling, ft., | 7,000 |
> | Distance Required To Get Off, yd., | 50 to 70 |
> | Distance Required To Pull Up., yd., | 20 to 25 |
>
> Compared with the performance of a modern airplane of the usual design the figures given above are by no means striking at first sight, but when it is pointed out that they are obtained with a power loading of 54.3 lb. per hp., whereas the corresponding figures for commercial and service airplanes are about 15 and 12 lb. per hp. respectively, it will be seen that they are of a distinctly high order. The wings have a span of 37 ft. and a dihedral angle of 4 deg.

The English Electric Co., who constructed the Wren, is now designing, on similar lines, a light two-seated machine with dual control.

FABRIC STRESSES IN PNEUMATIC TIRES. By H. F. Schippel. Published in *Industrial and Engineering Chemistry*, November, 1923, p. 1121.

The definite commensurable stresses to which the fabric of a tire carcass is subjected are classified as follows: static, including stresses due to inflation-pressure and those due to deflection under load; dynamic, including traction and braking stresses and centrifugal stresses. A mathematical analysis is made of each type of stress with a view to expediting future work in tire design, and a brief consideration is given to indeterminate stresses due to road shocks.

THE ANALYSIS OF CHROME-VANADIUM STEEL. By G. E. F. Lundell, J. I. Hoffman, and H. A. Bright. Published in *Industrial and Engineering Chemistry*, October, 1923, p. 1064.

The methods and observations, recorded in this paper, deal chiefly with accurate volumetric procedures and are based for the most part on data obtained during the standardization of the Bureau of Standards standard samples of alloy-steels.

The determinations of carbon, sulphur and silicon in chrome-vanadium steel offer no serious difficulties and are dismissed with references to acceptable methods and some precautions that have been found desirable. After vanadium

(Concluded on p. 16)

NOTES AND REVIEWS

Concluded

has been reduced to the quadrivalent state, the determination of phosphorus also offers no trouble and hence no detailed descriptions of the well-known methods for phosphorus are given. On the other hand, the determinations of manganese, chromium and vanadium offer some difficulties, and these are discussed at greater length and desirable methods that are not widely known are given.

MANUFACTURE OF RUBBER AND PYROXYLIN COATED FABRICS DIFFERS WIDELY. Published in *Automotive Industries*, Oct. 18, 1923, p. 794.

This paper, describing the manufacture of rubber-coated Fabrikoid, enumerates the important ingredients used, tells the method of preparing the coating and of regulating the thickness of the coating, discusses the serviceability of various colors and the three grades of lustre and concludes with three paragraphs of points that users should consider.

TEST SHOWS NO ABRASIVE IN BRONZE BUSHINGS. Published in *American Machinist*, Nov. 8, 1923, p. 689; reprinted from *Grits and Grinds*, September, 1923.

Describes an experiment, resulting in the conclusion that no abrasive is imbedded in the metallic surface as a result of the grinding operation.

GENERAL MOTORS DEVELOPS POROUS BEARING METAL. Published in *Automotive Industries*, Oct. 18, 1923, p. 793.

Gives a brief description of a new porous, oil-absorbing, copper-tin bearing bronze, called Durex, possessing a low coefficient of friction and an unusual ability to resist wear. The paper describes the method of installation of Durex bearings and gives directions for the best results from their use. The physical properties of the metal are listed as follows: Brinell hardness, 30-40; scleroscope hardness, 15-18; modulus of elasticity, 2,500,000; weight, 3.5 oz. per cu. in.; specific gravity, 5.40; oil absorption, 25 per cent by volume; compressive elastic-limit, 2000 to 10,000 lb. per sq. in., depending on composition.

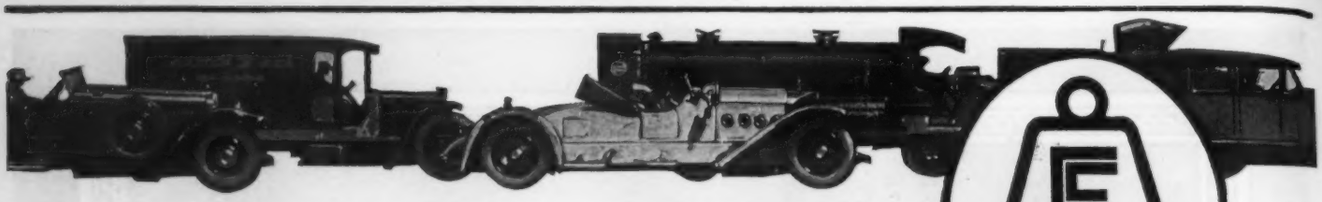
THE MOTORAILER WHEEL FOR MOTOR VEHICLES. Published in *Engineering*, Oct. 12, 1923, p. 472.

This short article, illustrated by seven diagrams and two photographs, is concerned with a wheel system that can be converted from the form required for railway or tramrail service to one suitable for the road and the reverse. It has been demonstrated that the conversion from road to rail service, including the removal of four tires and rims and the locking of the steering gear, can be effected by two mechanics in about 8½ min., while the reverse operation can be accomplished in 29 min.

The motor wheel is of the rail-track type, made of high-carbon steel. To convert this into the road form, a cast-steel rim, with a ¼-in. gap cut out of it in the way common with piston-rings, is placed around the wheel to provide the requisite horizontal face for the rubber tire. The rim is held in place by six bolts that pass through the holes at the thickened top ends of the spokes; these bolts have sector-shaped heads that engage in recesses cut into the underside of the rim and are fitted with screwed pins for use in liberating the rim once the nuts are removed. The shafts of the bolts pass through the rim of the wheel and the nuts bear against the inner face.

ELECTRIC RAILWAY AND TRUCK TRANSPORT COMBINED BY USE OF CONTAINER CARS. By D. M. McDonald. Published in *Automotive Industries*, Oct. 4, 1923, p. 678.

Gives an account of a plan to combine railway cars and motor trucks for the transportation of freight. Among the advantages mentioned are economy and the convenience of door-to-door service. Demountable containers, loaded by the shipper, will be transferred from the truck to the railway car, from the car to the truck again and then to their destination, thus necessitating the minimum of handling. The container is really a small-sized freight car, being used as a substitute for the large car on less-than-carload shipments; all containers are on ball-bearing wheels and the largest, fully loaded, can be moved by one man.



Wherever the Eaton trade-mark is found the product which bears it is stamped as one of sterling quality. Eaton is a synonym for excellence in the automotive world.

"EATON MEANS EXCELLENCE"

EATON AXLES

It is a significant fact that the cars using Eaton Axles are among those generally accepted as leaders in quality.

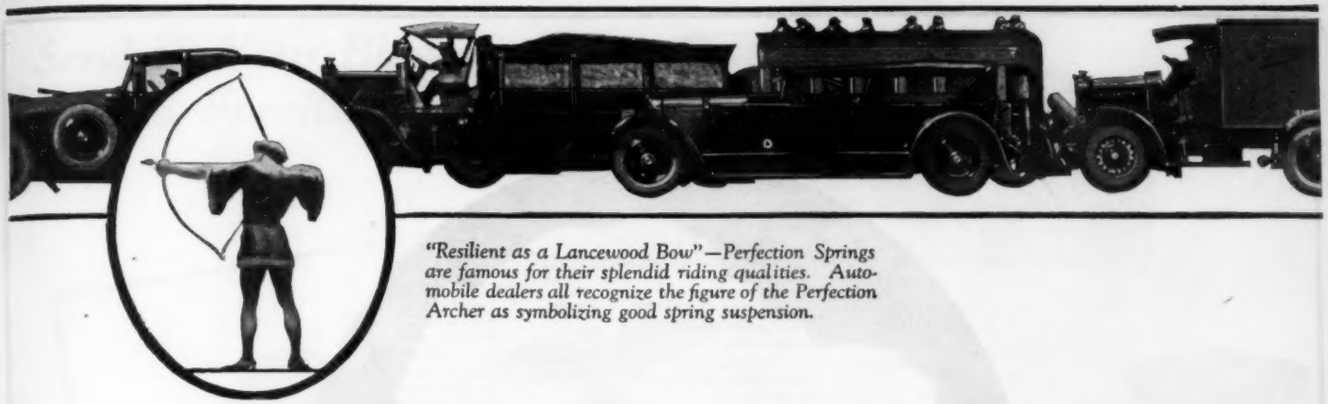
This simply means that Eaton standards are identical with those of the leading fine car manufacturers.

Correct design, careful selection of materials and extraordinary precision in manufacture, make certain that every Eaton Axle embodies the full efficiency of whatever type it represents —bevel gear, worm gear or double reduction.

Ask the builders of America's finest cars.

An EATON PRODUCT

The EATON AXLE & SPRING



"Resilient as a Lancewood Bow"—Perfection Springs are famous for their splendid riding qualities. Automobile dealers all recognize the figure of the Perfection Archer as symbolizing good spring suspension.

PERFECTION SPRINGS

Intelligent co-operation—both in engineering and production—with car and truck manufacturers, is one of the reasons for the "Perfection" reputation.

Our experience of seventeen years in working out the practical problems of spring suspension has been of untold value to our customers.

And in the actual making of the springs, our knowledge of steel and of heat treatment, our insistence on a uniformly good product, and our willingness to give extraordinary service when necessary, are mighty good reasons for car and truck builders preferring "Perfection."

An EATON PRODUCT

COMPANY ~ ~ ~ Cleveland

Your Triumph

The car specifications are the evidence of *your* triumph in engineering accomplishment.

Every part of that car is the result of thought and study on *your* part. More than anyone else in your company, *you* appreciate the full importance of every detail of its mechanical construction and the advisability of listing all vital parts in the printed specifications.

Automotive engineers readily admit that the ignition, starting and lighting cables comprise a vital unit.

Many are recommending that Packard Cable be a part of the printed specifications.

The Packard Electric Company

WARREN, OHIO

MANUFACTURERS OF PACKARD AUTOMOTIVE CABLES

BAKELITE

REG. U.S. PAT. OFF.

1 2 3 4 5

BAKELITE solves a precision assembly problem for ARROW-LITE

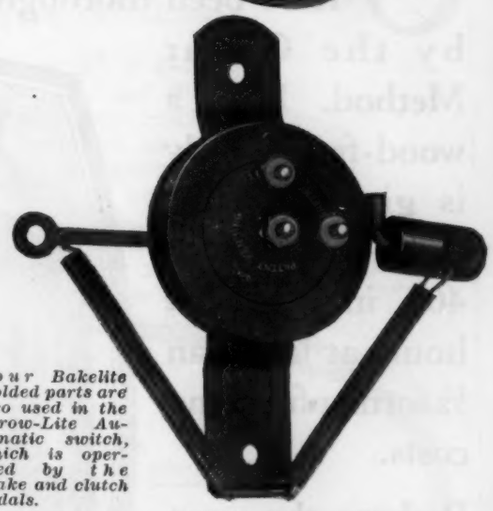
Only 1 5/8 inches in diameter, and with four separate electrical contacts to be provided for, this Arrow-Lite Signal Switch presented a difficult manufacturing and assembly problem.

How completely Bakelite molded parts met the requirements is clearly shown in the photographs above.

1. Base, molded with finished flanged hole for electrical conductors, and with sharp, clean-cut lettering.
2. Contact Block, molded with five metal contacts permanently embedded.
3. Cap, molded with lettering in sharp relief and with metal inserts for assembly screws.
4. Thumb Switch, with molded tip.
5. Complete Arrow-Lite Switch, an assembly of four Bakelite molded parts that snap together with "Watchcase" precision.

The adoption of Bakelite molded parts is simplifying design, reducing assembly costs, and improving quality, for many manufacturers.

Engineers, designers and production managers are cordially invited to enlist the cooperation of our research departments.



Four Bakelite molded parts are also used in the Arrow-Lite Automatic switch, which is operated by the brake and clutch pedals.

BAKELITE CORPORATION
247 Park Avenue, New York, N. Y.

Plants

Perth Amboy, N. J. — Bloomfield, New Jersey
636 W. 22d St., Chicago, Ill. — Painesville, Ohio

BAKELITE
Condensite
REDMANOL
are the registered Trade Marks for the Phenol Resin Products manufactured under patents owned by
BAKELITE CORPORATION

THE MATERIAL OF A THOUSAND USES

ESTABLISHED 1903

THE DETROIT TESTING LABORATORY

3726 WOODWARD AVENUE

DETROIT, MICH.

November 17, 1923.

Oxford Varnish Corporation,
Detroit, Michigan.

Gentlemen:-

We have conducted an investigation of your "Oxvar" method of wood treatment and submit our report as follows:

Test pieces, each finished to about 1" x 1-3/4" x 14", were prepared from kiln dried Birch, Maple, and White Ash. All tests were made in triplicate so that averages could be obtained. Static bending tests were made on samples as received and after the "Oxvar" treatment, readings being taken of maximum load, and deflection at first failure in each case.

The "Oxvar" treatment was carried out in your laboratory, under our supervision, to simulate in every respect your standard procedure for treatment of automobile frames and subsequent enamelling of bodies, heating the pieces to a maximum temperature of 400 degrees Fahrenheit.

Results of Bending Tests.

	Maximum Load		Deflection	
	No Treatment	Treated	No Treatment	Treated
Birch	3,198 lbs.	3,442 lbs.	0.300 inch	0.225 inch
Maple	3,306 "	3,655 "	0.260 "	0.240 "
Ash	2,333 "	2,530 "	0.280 "	0.245 "

Samples placed on edge, 12 inches between supports, load applied in center.

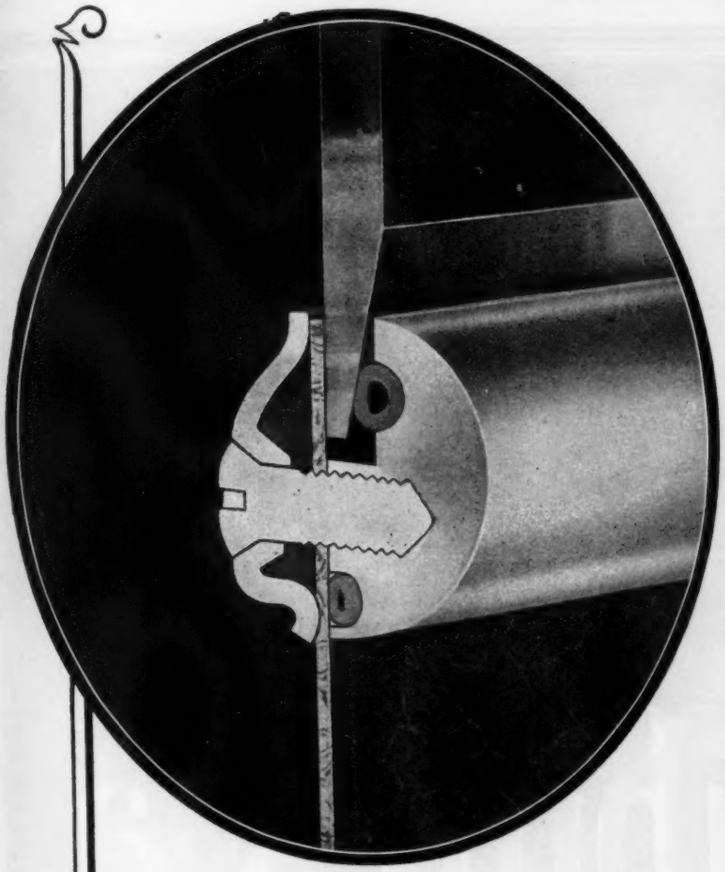
In our opinion, the particular advantage of your treatment is that the pores of the wood are so sealed that absorption of moisture, with consequent swelling or warpage, is practically impossible.

Yours very truly,

THE DETROIT TESTING LABORATORY.

Per C. L. Snyder
Registered Chemical Engineer

CLS/MB



Features of New Stewart Curtain Light

The inside frame is black enamel steel stamping designed to obtain the greatest possible strength, yet with sufficient flexibility to permit the insertion of glass of varying thickness.

The outside frame is an aluminum die casting, highly polished.

Live rubber tubing is cemented in the groove around the *outside edge* of the frame. The curtain fabric is pressed tightly against this live rubber, insuring a firm and permanent grip which prevents leakage.

Live rubber tubing is cemented in the groove around the *inside edge* of the frame, providing a cushion for the glass to prevent breakage and leakage. The glass cannot touch the metal frame.

The curtain fabric is trimmed inside of the frame, making the assembly very easy.

The nickel-plated steel screw is pointed to pierce the fabric where the frame is assembled.

Either beveled edge or plain crystal glass can be used.

Announcing to Automobile Manufacturers

A New Stewart Curtain Light

at competitive prices

This new Stewart Curtain Light is made to order for manufacturers who know that the good will of the purchaser depends upon entire satisfaction with every detail and appointment of the motor car.

The Rain-proof, Rattle-proof, Rust-proof features, which last longer than the car itself, are now available at the same price you pay for ordinary curtain lights.

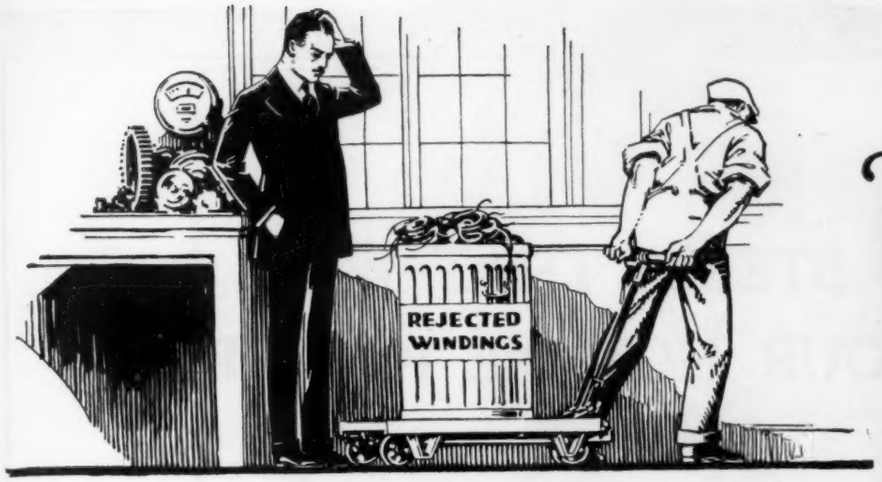
There is no secret about the manufacturing process that accomplishes this economy. The inside frame is an enameled steel stamping. The outside our usual die cast aluminum frame. Its design combines great strength with sufficient flexibility to permit the use of either bevel or plain glass of varying thickness.

We experience great satisfaction in uncovering this source of economy and providing Stewart Curtain Light advantages for manufacturers at such remarkably low prices. We are prepared to design and produce this new curtain light in accordance with your specifications and requirements.

Stewart

STEWART MANUFACTURING CORPORATION
4535 Fullerton Avenue Chicago, Illinois

Stewart Curtain Lights



Don't blame the winder

THE coil winder often has to force the last turn of magnet wire into place and hammer down the bulges. He takes extra time for this—time that you are paying for. He sends up the cost of the winding. He also swells your volume of rejected windings.

But it isn't the winder's fault. If the wire is uneven and lumpy, the specified number of turns won't always go in the space. He must do the best he can, even though he does risk spoiling the job.

There *is* a way to cut down this waste. You *can* get a magnet wire that lines up, foot after foot, mile after mile, uniform in diameter—a wire that "*goes in the space.*"

Acme Wire "*goes in the space*" because it is uniform, free from lumps, bare spots, and imperfections of all kinds. The last turn always falls snugly into place. Its smooth, unvarying coat of insulation is of high dielectric strength.

Acme Wire has cut winding costs in many cases. With it the operator turns out not only more coils, but more that pass inspection. He winds coils that stay on the job for years.

Find out for yourself how and why Acme Wire can trim down your winding costs and boost your percentage of perfect windings. A postcard will bring our descriptive literature to your desk without obligation.

THE ACME WIRE CO., New Haven, Conn.
NEW YORK CLEVELAND CHICAGO

Some Users of Acme Magnet Wire

Atwater Kent Mfg. Co.
Azor Motor Mfg. Co.
Century Electric Co.
Dayton Engineering Laboratories Co.
Delco-Light Co.
Diehl Mfg. Co.
Domestic Electric Co.
Eisemann Magneto Corporation
Electric Auto-Lite Corp.
Electric Specialty Co.
Electrical Products Mfg. Co.
Eureka Vacuum Cleaner Co.
Ford Motor Co.
Gray & Davis, Inc.
Hamilton Beach Mfg. Co.
Holtzer-Cabot Electric Co.
Hoover Suction Sweeper Co.
Klaxon Co.
Robbins & Myers Co.
Sangamo Electric Co.
Sunlight Elec. Mfg. Co.
U. S. Auto Supply Co.
Wagner Electric Corporation
Western Cartridge Co.
Westinghouse Elec. & Mfg. Co.

Acme Wire Products

"Enamelite," plain enameled Magnet Wire; "Cottonite," Cotton-covered Enamelite; "Silkenite," Silk-covered Enamelite; Single and Double Cotton Magnet Wire; Single and Double Silk Magnet Wire. We also have a complete organization for the winding of coils in large production quantities.

Acme Varnished Insulations

Varnished Cambrics, Silks and Papers. Varnished Tapes in rolls; straight or bias. Varnished Tubing (Spaghetti).

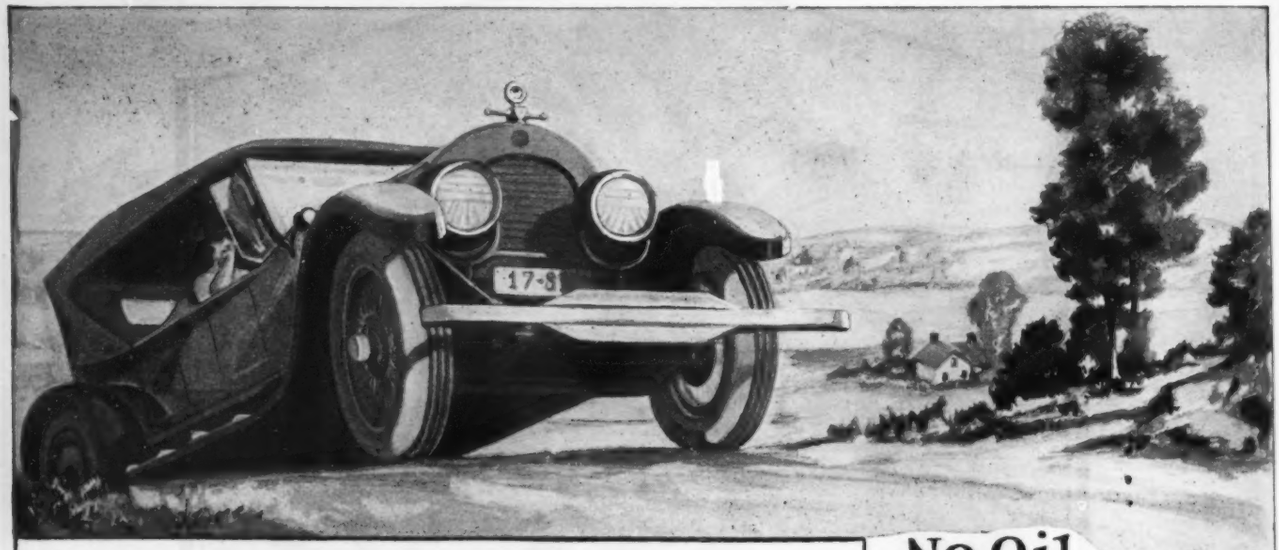
Acme Radio Specialties

Audio Transformer windings.
Radio Frequency windings.
Magnet windings for Head Sets.
Enameled wire—especially the finest sizes, 40-44 B & S gauge.
Silk and cotton-covered magnet wire.
Enameled Aerial wire—single wire and stranded.

Illustrated Catalog on request to Engineers, Purchasing Agents, Executives and Operators.

AcmeWire

"It goes in the space"



A new and better principle in Vacuum Fuel Feed-

Oil-Vac, the Kingston Vacuum Fuel Feeding System, does away entirely with the intake manifold as a suction source, utilizing instead the suction produced by the proper proportioning of the oil circulating pump.

With *Oil-Vac* there is certainty of increased suction with increased engine speed. When the greatest amount of fuel is needed, as in the case of long grades or at high speeds, the greatest amount is actually being delivered to the motor.

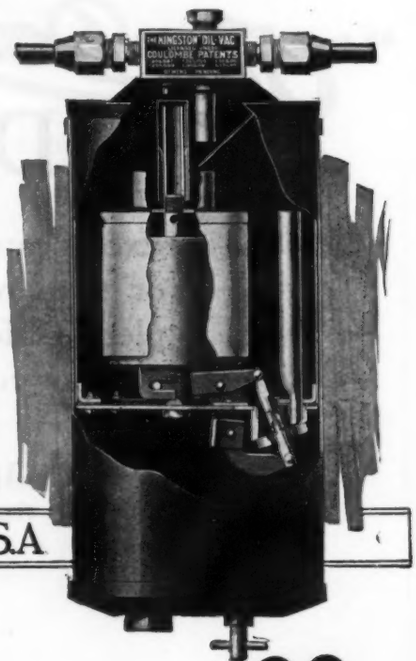
With *Oil-Vac* disturbance of carburetion is at a minimum, and crank case dilution is lessened to a marked degree. Oil runs cooler and lubrication is more efficient.

Automotive engineers generally are taking a deep interest in this *new* principle in vacuum fuel feed. A number of leading manufacturers have already adopted *Oil-Vac* as standard equipment, and many others are investigating its merits. A line to the manufacturers will bring complete information.

No Oil No Vac No Gas

With *Oil-Vac* the vacuum ceases when the oil supply becomes exhausted. No motor should run without oil, and no motor can run without oil for long without serious damage. This is one added feature of importance with *Oil-Vac,* a factor of safety that is worthy of consideration.

Send for the *Oil-Vac* Booklet



BYRNE, KINGSTON & CO. KOKOMO, INDIANA, U.S.A.

Branches
New York, 245 W. 55th St. Chicago, 1430 Michigan Ave.
Dallas, 2218 S. Harwood St. Detroit, 4610 Woodward Ave.
Boston, 15 Jersey St. Los Angeles, 1417 W. Pico St.

"Oil-Vac"

Performed 100% In Severe Test

Actual photo of rods after the completion of non-stop endurance run.

Rushing through space at an average speed of 62.63 miles, and at times exceeding 75 miles, per hour over a 3,155 mile course without stop subjects bearings to a strain that would never be demanded under ordinary conditions of driving.

Mogul Alloy Genuine bearing metal was used in the stock Duesenberg straight eight five-passenger touring car non-stop run on the Indianapolis Speedway, April 27, under the direction of the A. A. A., a distance equal to that between New York and Los Angeles being covered in 50 hrs., 21 min., 1 sec.

After this test run the engine was torn down under the supervision of the official observers of the A. A. A., with the result shown in the following letter to this company:

"I know you will be particularly interested in knowing that your parts performed 100% during this test."

Signed
DUESENBERG AUTOMOBILE & MOTORS CO., INC.
Chester S. Ricker, General Manager

MUZZY-LYON COMPANY
Detroit, Michigan

Mogul

Engine Bearings *and* Bearing Alloys

Every Driver Desires Easy Steering

Owner satisfaction depends in very great measure on the physical effort required to handle the car. The only point of constant application of physical effort is the steering wheel. The easier the car steers, the less physical effort, and logically increased pleasure in driving.

The easy steering and the powerful and easy control provided under all road conditions by the new Ross cam and lever steering gear arouses the keenest enthusiasm on the part of every driver. In straight-away driving, the gear is so irreversible that practically all road shock is eliminated. In turning, the variable pitch of the cam develops a unique accelerated action which facilitates quick and easy control —a feature which appeals to every driver when backing into flat-to-the-curb parking position.

Every motor car manufacturer who is interested in increasing owner satisfaction should investigate the easy steering of this new gear. Full information on request.

Steering Gears
for
Passenger Cars
Motor Buses
Motor Trucks
Fire Trucks
and
Tractors

ROSS GEAR & TOOL COMPANY
730 Heath St. Lafayette, Indiana, U.S.A.

ROSS STEERING GEARS

POWER ~ SAFETY ~ RELIABILITY and EASY STEERING

Worn Out—Just rubbed in air

A chunk of fire strokes the night sky and is gone. Where?

Swallowed by Friction. Literally burned to nothingness, actually worn out of existence, simply by rubbing the air.

That's all a "shooting star" is. A mass of mostly mineral substance, flung from some whirling body of the skies, hurtling through the airless voids of the universe, until it happens to fly into the layer of air which surrounds our earth.

Just rubbing the atmosphere kindles the blazing ball you see, the "shooting star." The friction of just moving through the air is what utterly consumes it.

Anything which moves, however fast or slowly, even in the thin invisible air, or on finest lubricating oils, is inevitably subject to the wear of *motion*.

It is motion, as you know, which wears your motor car. How long your automobile will last, how smooth-running and quiet you can keep it, depends then upon how well you are permitted to compensate for the wear that *must* follow motion.

You are sure there *will be* wear from motion. To enable you to offset the chief effects of this certain wear, make sure the principal revolving parts are mounted on bearings which can be adjusted. The basic principle of anti-friction bearing adjustability is embodied in Timken Tapered Roller Bearings. THE TIMKEN ROLLER BEARING CO., *CANTON, OHIO.*

TIMKEN
Tapered
ROLLER BEARINGS

The Explosive Action

of the Bowen-Empress Gun shoots a charge of the lubricant into the bearing under high pressure, driving out the dirt, grit and old dead grease, leaving the bearing completely covered with a film of fresh, clean lubricant.

Before applying the Bowen-Empress Gun to the fitting on the bearing, pressure is first developed in the gun by turning the plunger forcibly against the lubricant. A check valve in the nozzle holds the pressure within.

Next, using one hand only, the connection cover is lifted with the slotted gun end and the nozzle thrust into the connection, the valve in the nozzle coming in contact with the trip in the bottom of the connection, releasing the pressure and instantaneously flooding the bearing with a charge of the lubricant. The dust tight connection cover is then snapped shut, using the gun end. Then withdraw the gun and develop the pressure for the next bearing.

Quick, Clean and Convenient. No connections to make between gun and fitting. No easily mislaid dust caps to remove and replace. No dirt collecting open ball check fittings. No flexible hose to break under pressure. Unnecessary to lock gun to fitting on bearing or to turn back plunger to relieve pressure before removing gun from fitting on bearing.

The Bowen-Empress System can be used with either oil or grease as the lubricant.

Bowen Products Corporation

Auburn Division, Auburn, N. Y.

Write for Descriptive Booklet No. N-301

One Hand Operates It.

Bowen-Empress

HIGH PRESSURE LUBRICATING SYSTEM

FOR ALL MOTOR CARS AND TRUCKS

Strom Service Department, Home Office, Chicago

The Golden Rule in Business

We give the kind of service we like to get

Strom service is as good as we know how to make it. We have studied what manufacturers need. And we have adapted our service to their needs.

On orders for ball bearings from stock we can frequently make shipments the same day the order is received.

Where technical advice is needed, our corps of experts is at your service. They are familiar with every type of ball bearing installation ever made. We will be pleased if you will call on us.

Our interest in our installations continues long after we have made delivery. We are concerned with the successful operation of our bearings throughout their lives.

We believe in the golden rule in business. We give the kind of service that we like to get.

Double-acting thrust bearing, flat seats (grooved races) 2100-F Series

Single-acting thrust bearing, flat seats (grooved races) 1100-F Series

Single-acting, self-aligning thrust bearing 1100 Series

Single-acting, self-aligning thrust bearing, leveling washer, 1100-U Series

Double-acting, self-aligning thrust bearing, leveling washers 2100-U Series

Single-row deep-groove Standard type, radial bearing

Double-row, deep-groove Standard type, radial bearing

Angular contact bearing, combination radial and thrust

Double-row, maximum type, radial bearing

Single-row, maximum type, radial bearing

Strom BALL BEARINGS

"Wherever a Shaft Turns"

U. S. BALL BEARING MFG. CO.

4533 Palmer Street, Chicago, Ill.

AGATHON ALLOY STEELS

IMAGINE, if you can, the automotive industry without alloy steels. Think of the greatly increased bulk and weight that would necessarily have to be added to the cars of today. Think of the added cost of upkeep—the frequency of breakage—the added dangers of traveling at high speed.

Truly, alloy steels form the backbone of all that has been accomplished in the automotive industry in producing cars of greater speed, greater endurance, greater safety and greater comfort. In fact, many car builders have come to depend so heavily upon alloy steels that from seventy to eighty parts which are subjected to greatest stress and wear are made of these super-steels.

While all of our alloy steels are made under the "Agathon" trade name they embody various analyses, particularly suited to Axle Construction, Differential Frame, Front Axle, Motor Parts, Shafts, Transmissions, Springs, Steering Parts, etc. We have an interesting booklet entitled: "Agathon Alloy Steels," describing many of our steels for the automotive industry. Send for a copy.

We have daily production in all kinds of commercial alloy steels such as—

Nickel, Chrome-Nickel, Uma, Molybdenum, Chrome-Molybdenum, Nickel-Molybdenum, Vanadium, Chrome-Vanadium, Chromium, etc.

Deliveries in Blooms, Billets, Slabs, Bars, Spring Flats, Hot Rolled Strips, etc.

THE CENTRAL STEEL COMPANY, Massillon, Ohio

SWETLAND BLDG. CLEVELAND | BOOK BLDG. DETROIT | PEOPLES GAS BLDG. CHICAGO | UNIVERSITY BLOCK SYRACUSE | WIDENER BLDG. PHILADELPHIA

QUALITY Piston Rings are carefully wrapped in waxed paper and packed in this grey and royal purple box.

STANDARD OF THE INDUSTRY

MORE than one hundred leading manufacturers of internal combustion engines specify **QUALITY** piston rings for original installation—because they are accurate, quick seating, long lived and easy to install.

More than two hundred discriminating distributors choose **QUALITY** rings because they strive to give their dealers the utmost in QUALITY–SERVICE–PRICE.

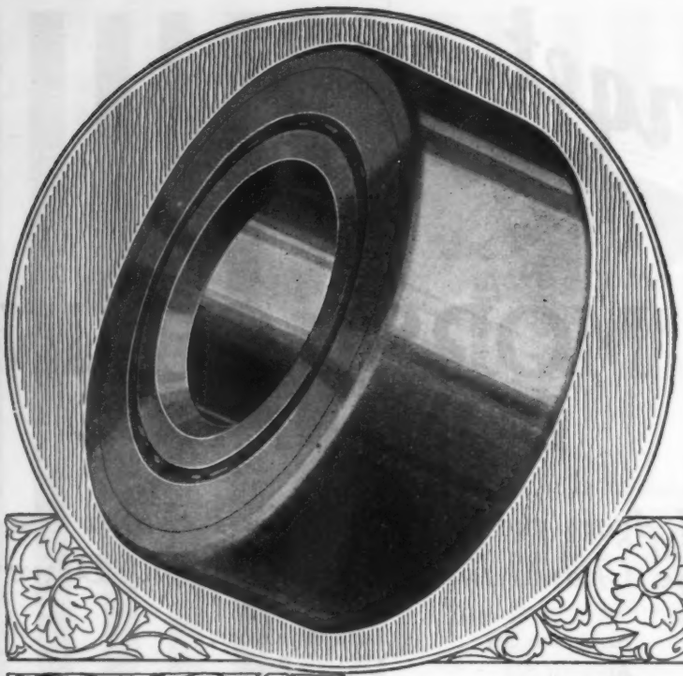
Thousands of dealers handle **QUALITY** rings for resale because giving the public what it wants—means low sales resistance with a resultant quick turnover.

The Piston RING COMPANY

Muskegon, Michigan

QUALITY
Piston Rings

"CAST TO LAST"



New Departure Ball Bearings

Why Ball Bearings, Anyway?

Depreciation in automobiles and trucks is largely a matter of parts wearing loose, with consequent lost motion and an imperfect functioning of one component in relation to another.

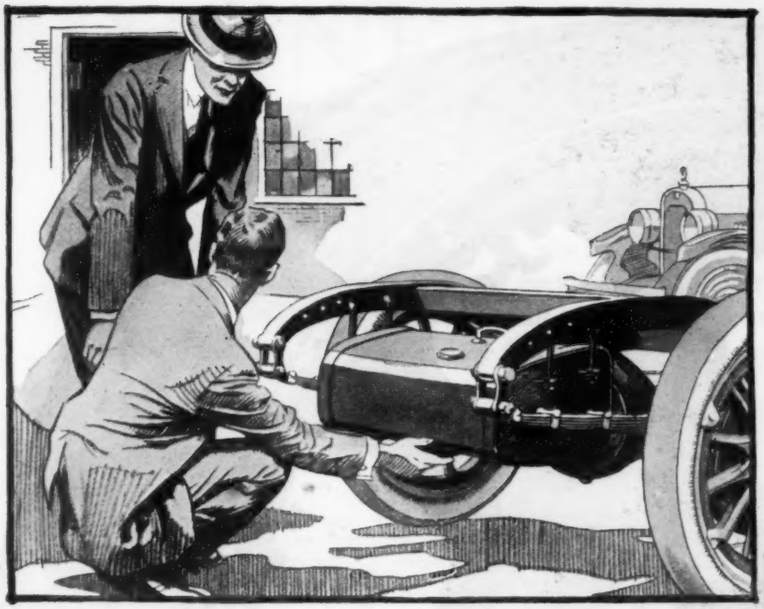
There are at least 29 vital points where moving shafts and gears depend upon anti-friction bearings for support. It is not so much the wear of the bearings themselves as the letting down and throwing out of alignment and adjustment of these shafts and gears. The replacement or "taking-up" of bearings does not help, because the damage is already done. To keep a vehicle "tight" you must never let it get "loose."

That is why New Departure ball bearings are needed. By very principle, design and materials New Departures do not wear perceptibly, and, barring accident or the entrance of abrasive material, need never be replaced.

Because this fact is being realized more and more, the New Departure plants are being called upon to produce the largest volume of quality ball bearings in their history.

THE NEW DEPARTURE MANUFACTURING COMPANY
BRISTOL, CONN.

Chicago Detroit



The sales arguments that count

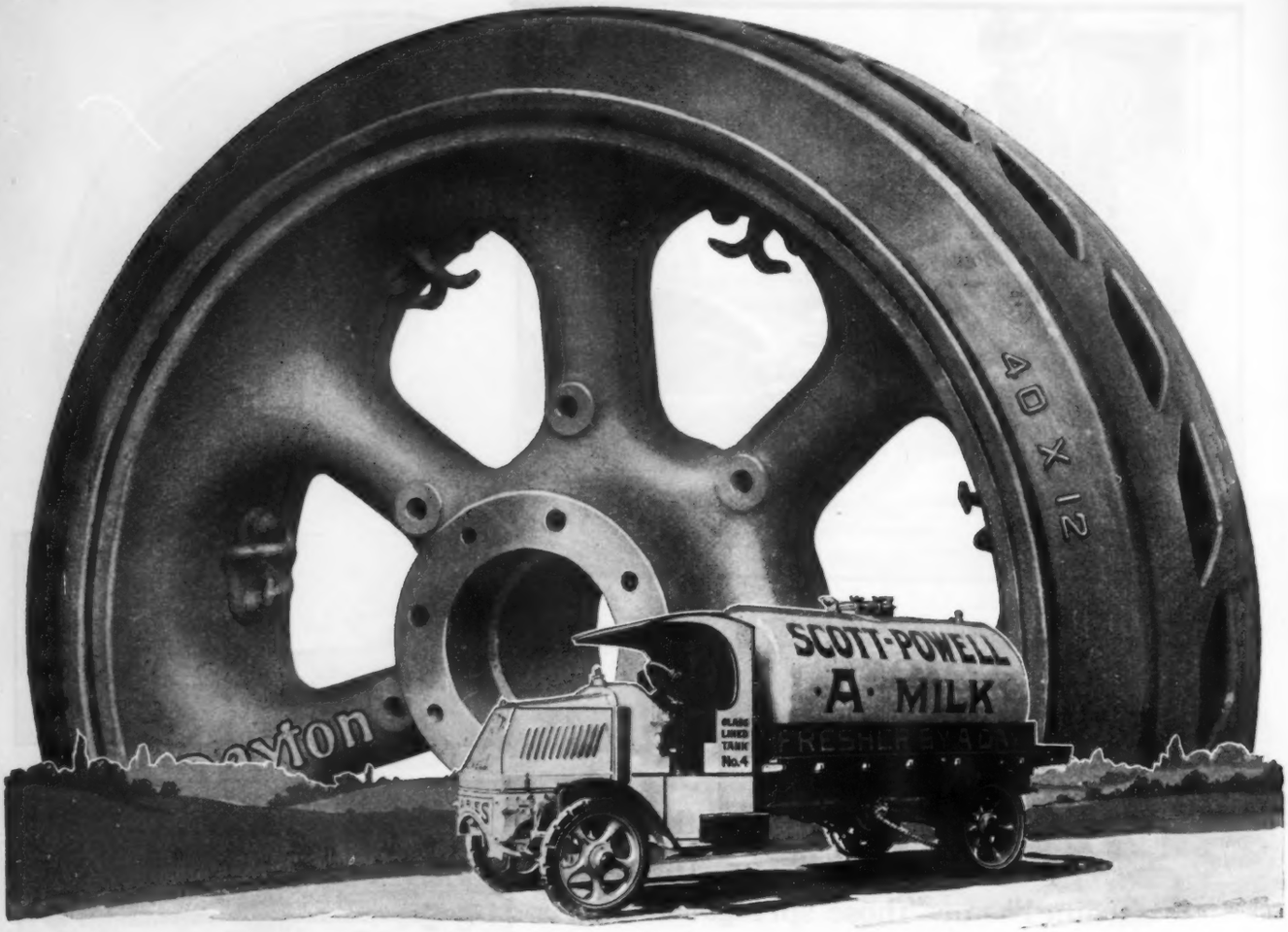
"LOOK at that axle!"—or "that propeller shaft!"—or "that frame!"—or "those springs!"—says the salesman.

He knows that these—the load-carrying and power-transmitting parts—are the points on which the shrewd purchaser today bases his final decision on which car or truck to buy.

And here's where the names of Spicer, Parish, Sheldon and Salisbury prove their power in closing the sale. Being *known quantities,* the customer accepts them without question.

Sheldon Axle and Spring Co. - Wilkes-Barre, Pa.
Parish Mfg. Corp. - - - - Reading, Pa.
Salisbury Axle Co. - - - Jamestown, N. Y.
Spicer Mfg. Corp. - - South Plainfield, N. J.

C. A. DANA, *President*



On the road every day of the year!

EXCUSES don't go in the dairy business. Heavy duty tank trucks must haul thousands of gallons of milk into cities from outlying rural points, every day of the year, no matter the condition of roads.

Many of these trucks carry their daily tanks of milk from dairy farms over a hundred miles distant from the city.

It is a significant fact that nearly all tank trucks of leading makes are equipped with Dayton Steel Wheels.

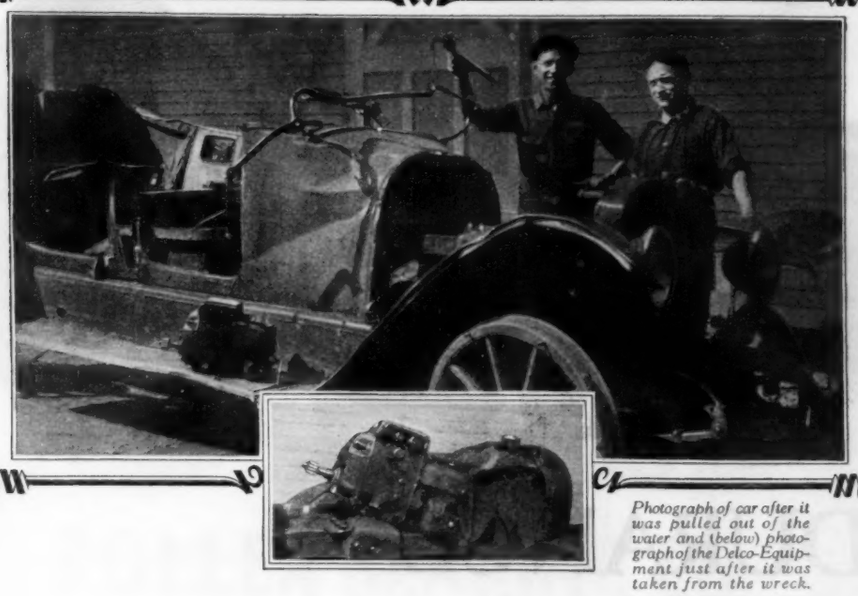
By the service they are rendering in the dairy business, Dayton Steel Wheels again prove that they are equal to meet, every day in the year, the most trying tasks of load and road.

Perhaps your haulage job is even more exacting than that of the dairy business. Whatever your particular requirements may be, Dayton durability and economy are worth investigating. Let us show you just what Dayton Steel Wheels will do for you.

Built for solid and pneumatic tires and for any standard type front or rear axle. Our Engineering Department will co-operate in working out your ideas.

THE DAYTON STEEL FOUNDRY CO., Dayton, Ohio

Dayton
Steel Truck Wheels



Photograph of car after it was pulled out of the water and (below) photograph of the Delco-Equipment just after it was taken from the wreck.

Submerged for six months in fifteen feet of water at the bottom of a quarry

THE DAYTON ENGINEERING LABORATORIES CO.
DAYTON, OHIO

GENTLEMEN:

We are writing you relative to the dependability of Delco equipment as brought to our notice recently.

In November 1922, a Hudson 6-40 car disappeared from Rutland, Vermont and was supposed to have been stolen. In May of this year, this car was found in an abandoned quarry two miles south of this place in about fifteen feet of water. The water was being pumped out and the car was found at this level. The job of removing the car was given to us by the insurance company and we afterwards purchased it. The top and upholstery had rotted and we took the chassis and motor down for parts. We took the Delco starter and generator off completely and, after drying out the water in this equipment, connected a storage battery to the terminals and found that the armature responded immediately.

As a matter of curiosity we installed this starter and generator in another Hudson car and found that it worked absolutely perfect in every way.

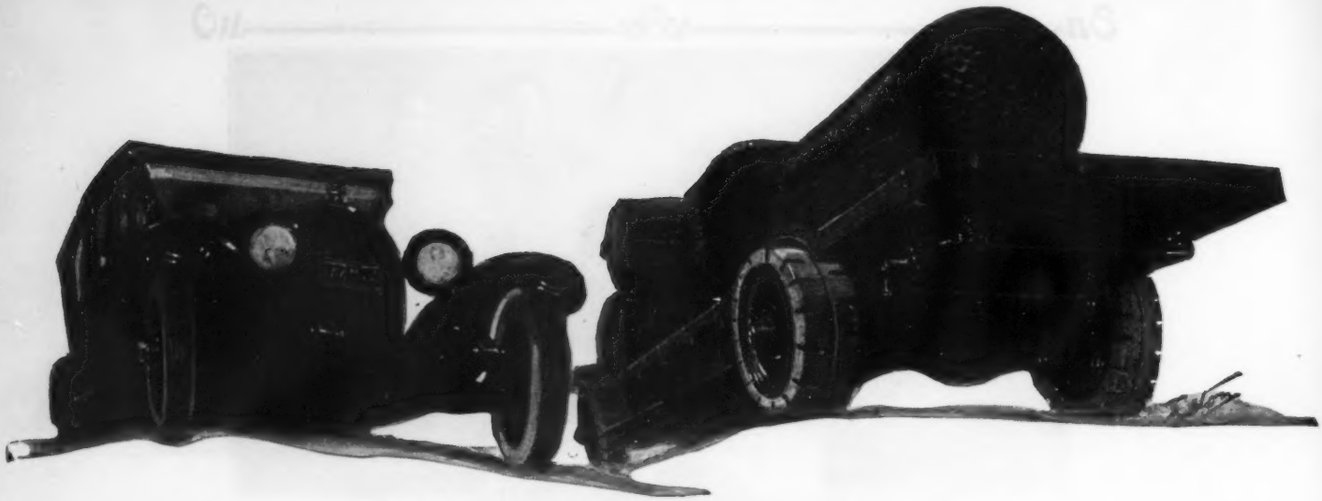
Very truly yours,

H. B. TOWNSEND,

August 24, 1923 WALLINGFORD, VT.

Delco

STARTING, LIGHTING AND IGNITION



ENDURANCE—

The Criterion of All Motor Car Value

The true standard of motor car value is constantly becoming more clearly defined in the public mind. It was first appreciated in the truck—this fundamentally an investment, with endurance standing practically alone to determine the soundness of the buyer's judgment.

But today, in the passenger motor car where this factor not only determines its span of life and resale value, but the comfort, and quietness of its service, the car's foundation is being accorded deserved consideration.

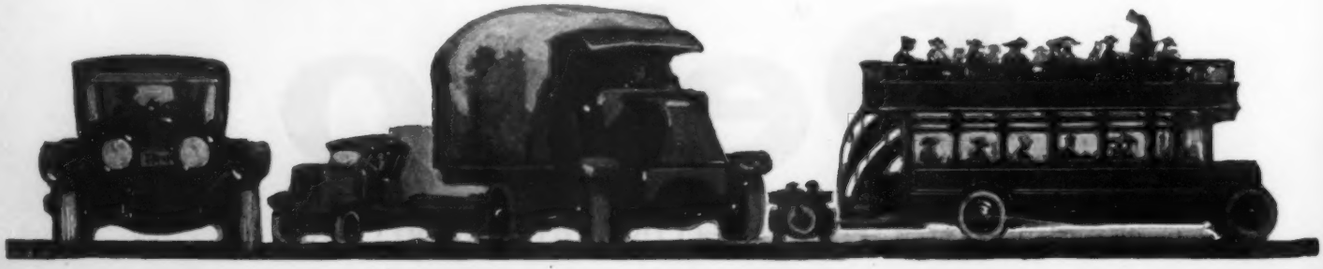
Since the inception of the automobile, when the name of Smith was linked with the first pressed steel frame produced in America, these engineers have been considered authority, and the product of their skill and experience incorporated in any car furnishes a sound basis for confidence in the investment.

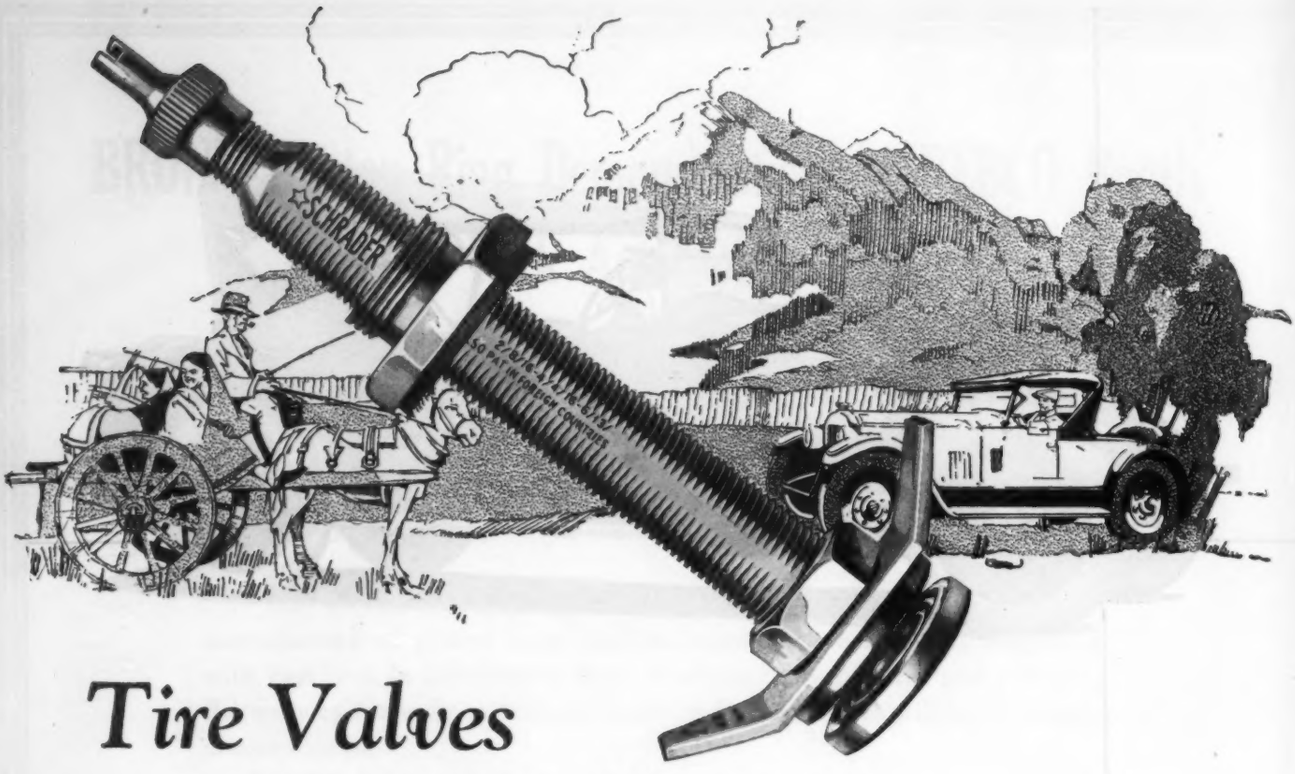
Smith frames are the product of the world's largest and best equipped frame plant. The complete laboratories, modern equipment, and engineering departments provide the utmost in dependability and service as a source of supply for even the largest automobile builders.

A. O. SMITH CORPORATION

Milwaukee, Wisconsin

DETROIT OFFICE: 708 FORD BUILDING





Tire Valves aid Ireland's progress

IN the land of linens and rugged coasts, Ireland's quaint jaunting-car no longer keeps the center of the road. For the whirr of many motors can be heard across the bogs, crags and dells; and Ireland rides—like the rest of the world—on air held in pneumatic tires.

From the time the first pneumatic tires were made, their life and service have largely depended upon the ability of their tire valves to retain air. A tire can give full mileage only when its valve effectively holds air.

Schrader Valves are air-tight

Wherever civilized man uses motor cars, Schrader Universal Tire Valves are on duty. They successfully retained air in the first pneumatic tire made in the United States. Since then these valves have become standard equipment for pneumatic tires.

Every part of a Schrader Valve is perfectly constructed by skilled workmen. Careful assemblage and rigid inspection further guarantee Schrader Valves to ceaselessly hold in air and enable tires to give their maximum mileage.

Large stocks always ready

Tire manufacturers and supply houses can get immediate shipment of Schrader Products from our large stocks. These products include Schrader Valve Insides, Valve Caps, Bridge Washers, Hexagon Nuts, Rim Nuts, Dust Caps and Bushings.

A. SCHRADER'S SON, Inc., Brooklyn, N. Y.
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Schrader

Makers of Pneumatic Valves Since 1844

Tire Valves · Tire Gauges

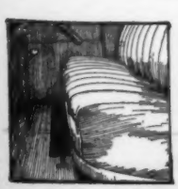
This year it required twice as many Perfection Heaters to meet the public demand for driving comfort as were used last year.
This proves that car buyers are sold on Perfection Heaters—it proves that year after year Perfection Heaters are demonstrating the dependable performance which has made this equipment the acknowledged leader in its field.

The Perfection Heater & Manufacturing Co.
6545 Carnegie Avenue Cleveland, Ohio

Manufactured in Canada by
Richards-Wilcox Canadian Co., Ltd.
London, Ont.

"The heat is there—why not use it?"

PERFECTION MOTOR CAR HEATERS



These manufacturers provide real winter driving comfort by equipping their closed models with Perfection Heaters without extra charge.

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Buick 6-Cyl.	Gardner	Nash 4-Cyl.	Sterling-Knight
Case	Henney-6	Nash 6-Cyl.	Stevens-Duryea
Cunningham	Hupmobile	National	Studebaker
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The real works of an automobile heater are hidden under the floor. You can't SEE the quality. Your Safeguard is the Perfection name-plate which you will find on every Perfection Heater.

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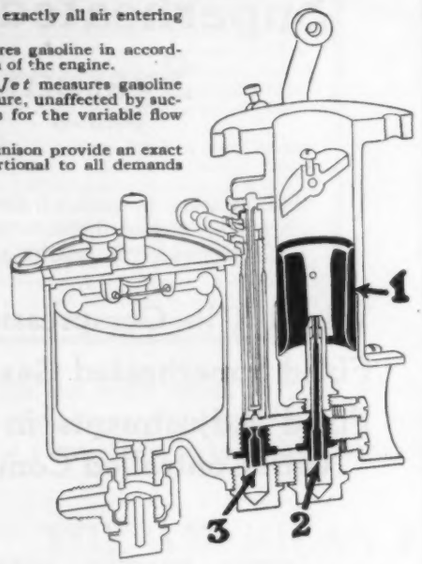

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The Zenith construction, with fixed control of all factors affecting the mixture, allows you to determine exactly the correct setting for your motor, and know it will be maintained.

The Zenith method of manufacture and inspection assures you that every carburetor furnished in production is an exact duplicate in construction and in performance of the one approved by you.

Thus Zenith means uniformity not only in your output, but also in results attained in the hands of users.

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*Light Mfg. & Foundry Co.
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*Long Mfg. Co.
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EXPLANATION OF SYMBOLS

Parts and materials followed by key numbers have been standardized by the S. A. E. The numbers refer to S. A. E. HANDBOOK data sheets on which each standard is published.

*Companies whose names are preceded by an asterisk supply the parts or materials under which the company is listed as conforming with the S. A. E. Standard referred to.

**Parts and materials followed by two asterisks indicate that two or more S. A. E. Standards are applicable. Information as to standards incorporated should be obtained from the manufacturer.

The addresses of companies listed in this index can be obtained from their current advertisements indexed on page 110.

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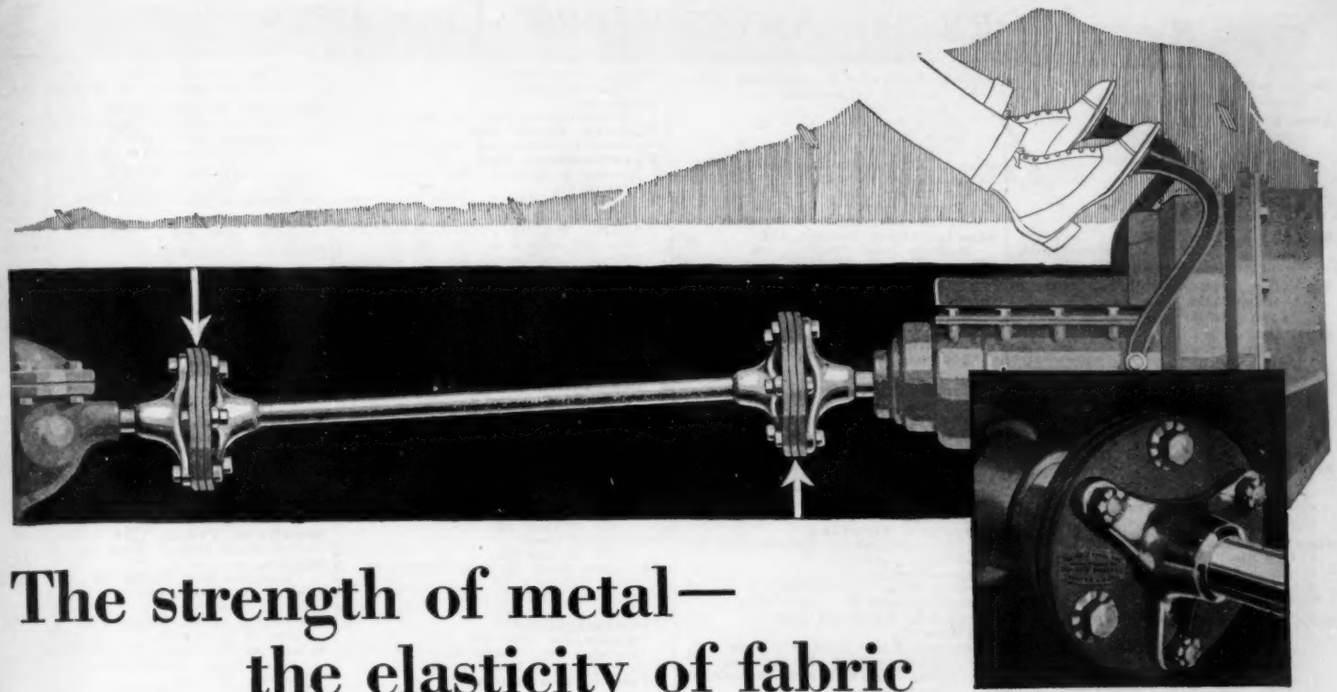


The strength of metal— the elasticity of fabric

Fanwise Construction has made the Thermoid-Hardy fabric disc a practical necessity for motor cars

For years motorists endured the knocks, jars, and lost motion caused by the wear-down of metal universals. Delicate gears and bearings suffered irreparable injury.

Then the fabric disc was invented. Its flexibility cushioned the blows of starting, shifting, and bumping over rough roads. But not until Fanwise Construction was perfected did the fabric universal overcome every previous objection.

Balanced to meet every stress

Take a look at the diagram of the Thermoid-Hardy disc. It is built up fanwise, each layer overlapping and turned. The strands of each layer run in a different direction. Each sector is of uniform strength and elasticity. Every stress is balanced—

—the torsional, between the bolt holes
—the centrifugal, from the center outward
—the lateral, from the forward and back motion of the shaft.

This holds the shaft in true on every revolution. It eliminates vibration and "whipping."

Now notice the diagram of the ordinary fabric universal. Built up so that only *one* driving bolt can pull "with" the strands of cotton—the other two tugging *across* them—your disc soon stretches out of shape. Vibration naturally follows, bringing jars and lost motion.

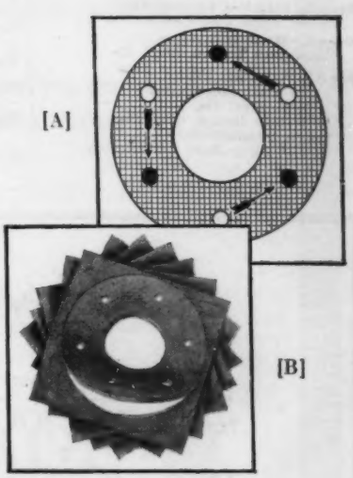
Only in the Fanwise Construction of the Thermoid-Hardy disc do you get the flexibility of fabric, the rugged strength of metal.

Thermoid-Hardy discs are now packaged for distribution through jobbers and dealers for replacement sales. Full information, prices, and discounts sent on request.

A book you should have

We have prepared a book, "Universal Joints—Their Use and Misuse," that treats the subject from every angle—the mechanical principles, construction, lubrication, manufacture, strength tests, and records of performance. Send for your copy today.

THERMOID RUBBER COMPANY
Sole American Manufacturers
Factory and Main Offices: Trenton, N. J.
New York, Chicago, Los Angeles, Detroit, Atlanta, Seattle, Kansas City, Boston, Cleveland, San Francisco, London, Paris, Turin



[A] *Above is an ordinary fabric disc, its layers of fabric laid parallel. The three black holes are the driving bolts—the three white ones the driven. Note that the left hand driving bolt is the only one that can pull in the direction of the cotton strands. The other two must pull on a bias. This stretches the whole disc out of true, causing vibration and "whipping" of the shaft.*

[B] *Now examine the Thermoid-Hardy patented Fanwise Construction. The disc is built up with the strands of each layer running in a different direction. Each sector is equally strong, equally elastic. Every stress is balanced—the torsional, the centrifugal, and the lateral. This eliminates vibration and holds the shaft in true on every revolution.*

THERMOID-HARDY
UNIVERSAL JOINT

Makers of "Thermoid Hydraulic Compressed Brake Lining" and "Thermoid Crolide Compound Tires"

Allis Chalmers Mfg. Co.
The Autocar Co.
Available Truck Co.
Barley Motor Car Co. (Roamer)
Chandler Motor Car Co.
Crow-Elkhart Motor Corp.
Jas. Cunningham Son & Co.
Dart Truck & Tractor Corp.
The Dauch Mfg. Co.
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Highway Motors Co.
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INDEX TO ADVERTISERS

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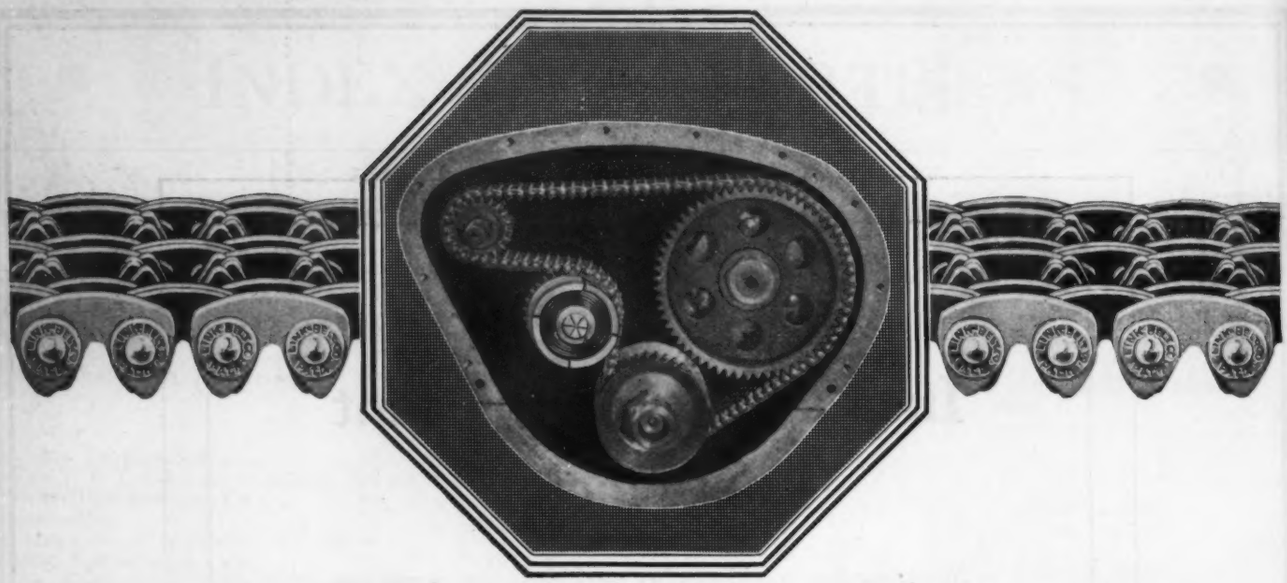
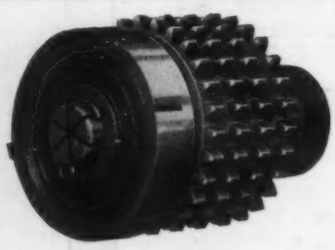


A Triumph of Engineering Skill

Silence and efficiency in operation are the result of perfection in design, material and workmanship—



The Link-Belt
Automatic Chain Tightener
(*Vibration Dampener*)

A sweet-running quiet motor is a powerful sales argument. Any cost differential between the Link-Belt Silent Chain "Front-End" Drive and usual timing-gear sets is offset by ease of assembly in the factory, elimination of all "running in" and "mating" of gears, and reduction to a minimum of costly servicing and replacement.

THE car buyer's demand for a quiet-running engine was successfully met by the Link-Belt Silent Chain "Front-End" Drive with the effective Link-Belt Automatic Tightener—a distinct advance over all types of front-end drives.

The verdict of manufacturers, engineers and car owners, *based on actual tests,* is unanimous:

"The Link-Belt Silent Chain 'Front-End' Drive is noiseless when it starts and remains noiseless during its entire life".

There is no better guarantee than performance on the road. Mileage records of Link-Belt-equipped cars, as high as 76,000 miles (without need of "front-end" service), must be considered as the most valuable part of the Link-Belt guarantee as to the quality, efficiency and dependability of the Link-Belt Silent Chain "Front-End" Drive.

Our Engineers will work with yours to achieve a quiet motor.

LINK-BELT COMPANY, INDIANAPOLIS

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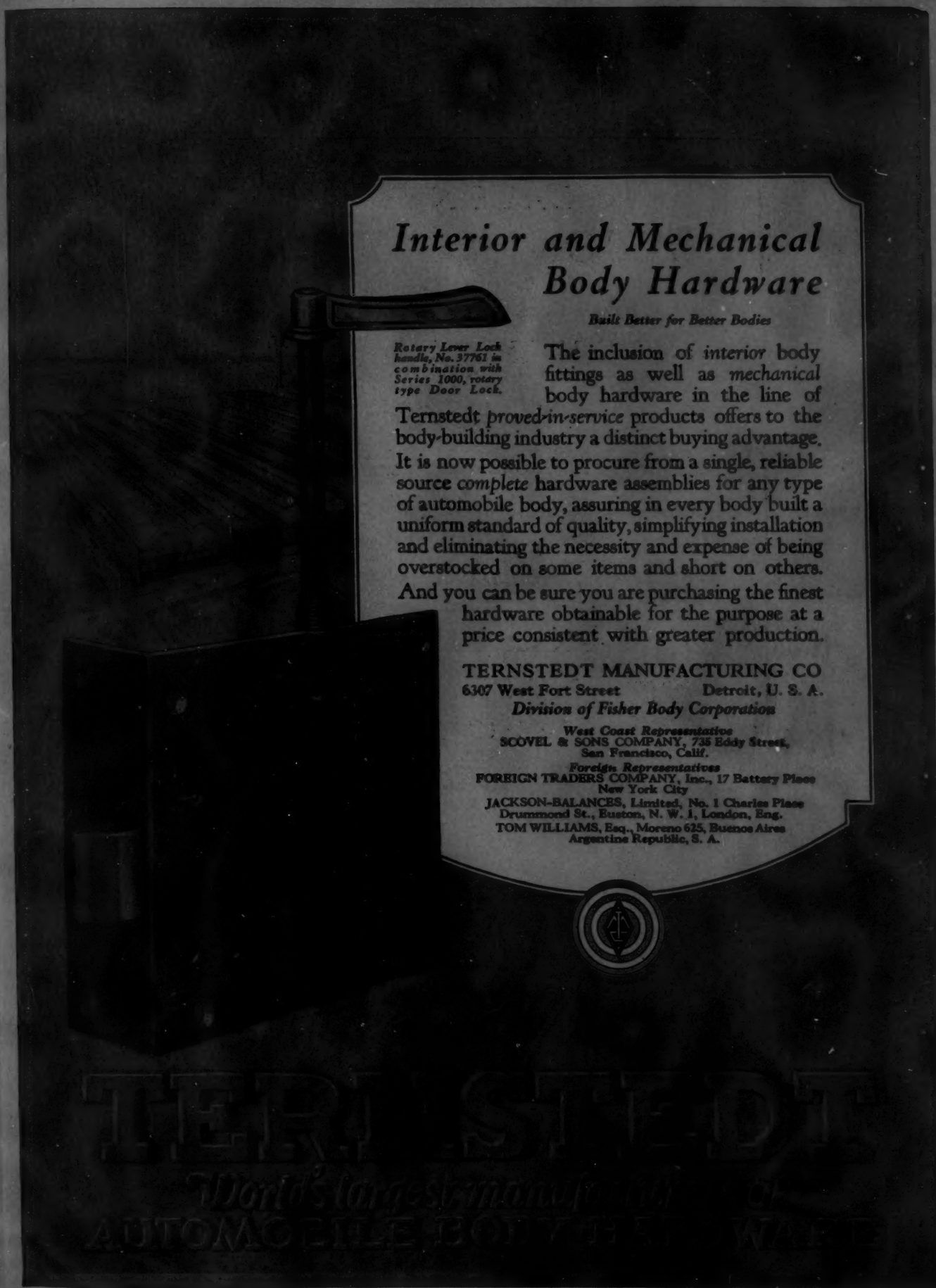
LINK-BELT

SILENT CHAIN FRONT END DRIVES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Built Better for Better Bodies
Rotary Lever Lock handle, No. 37761 in combination with Series 1000, rotary type Door Lock.
The inclusion of interior body fittings as well as mechanical body hardware in the line of Ternstedt proved-in-service products offers to the body-building industry a distinct buying advantage. It is now possible to procure from a single, reliable source complete hardware assemblies for any type of automobile body, assuring in every body built a uniform standard of quality, simplifying installation and eliminating the necessity and expense of being overstocked on some items and short on others. And you can be sure you are purchasing the finest hardware obtainable for the purpose at a price consistent with greater production.
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CALENDAR
NATIONAL MEETINGS

AMERICAN PETROLEUM INSTITUTE MEETING
St. Louis, Dec. 11-13

MOTORBOAT MEETING
New York City, Jan. 9, 1924

THE ANNUAL DINNER
New York City, Jan. 10, 1924

ANNUAL MEETING
Detroit, Jan. 22-25, 1924

THE CARNIVAL
Detroit, Jan. 23, 1924

DECEMBER, 1923